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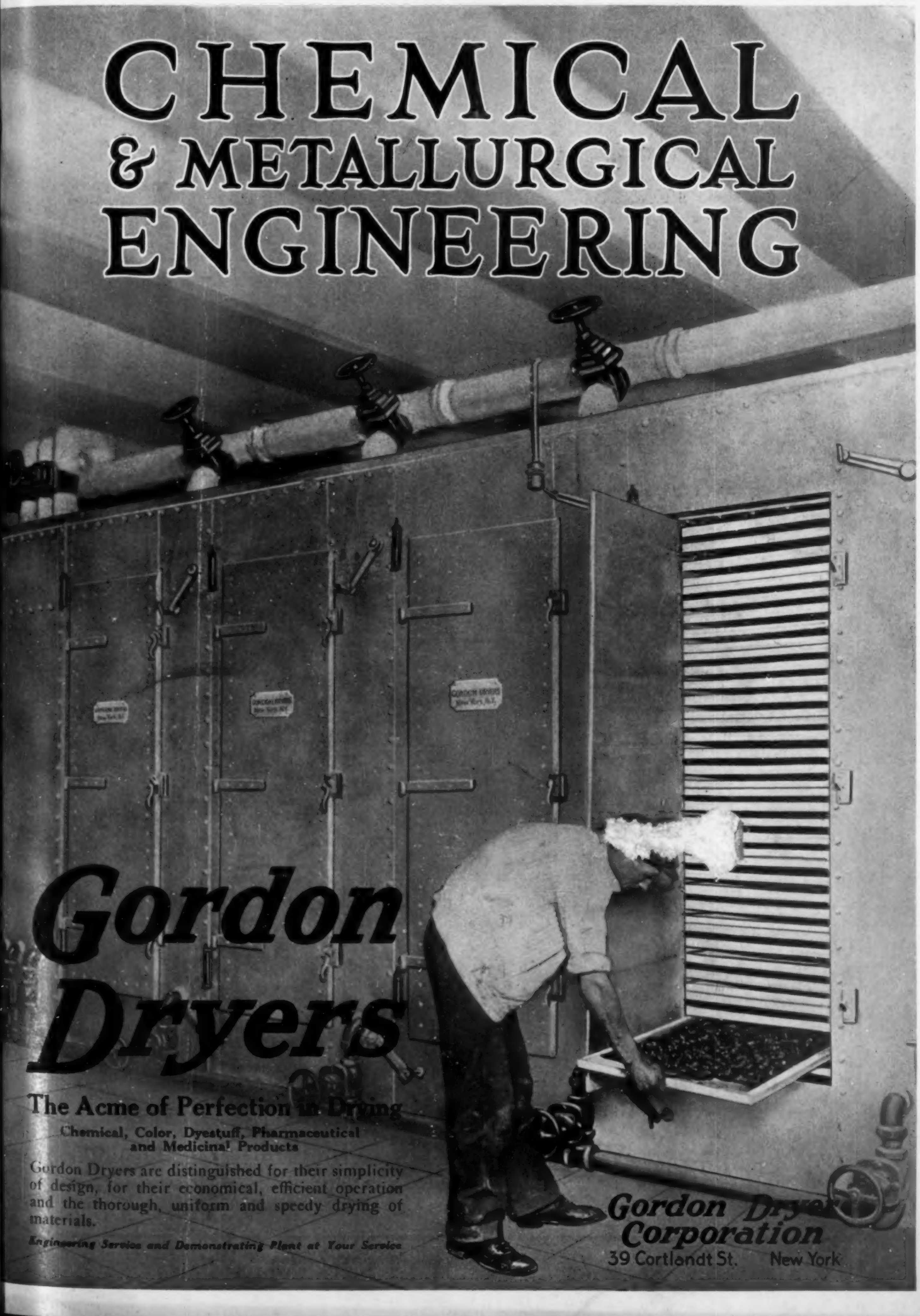

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CHEMICAL & METALLURGICAL ENGINEERING

A *consolidation of* ELECTROCHEMICAL & METALLURGICAL INDUSTRY *and* IRON & STEEL MAGAZINE

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Volume XX, *Number* 10

The Rude Awakening

IT WAS not to be expected that the Germans would receive the treaty in the spirit of defeated sportsmen, for as has been pointed out in this journal there is no equivalent in their language for the English word "sportsman," and the German mind probably is devoid of an instinct for which it has no distinctive word. And speaking of words not in the German dictionary, MR. JAMES M. BECK commented in a speech before the English-Speaking Union in London on the absence of any equivalent in German for the English exclamation "Bully!" "It seems strange," he added, "because they give so many exhibitions of the characteristics of the bully."

Throughout the war German psychology has been a source of wonderment to the rest of the world, because just when the mystery of it seemed to be understood, new and strange phases were exhibited. The arrogance and insolence displayed when they were apparently winning the war and which led them to announce boldly the terms which they would exact of their defeated enemies are exhibitions of the same spirit that now whines over the realization of its defeat. Whom the gods would destroy they first make mad, and the German madness of the last forty years which led to their idea of world conquest certainly has wrought their destruction.

During the Spanish war we had the slogan "Remember the Maine!" but there are so many things to remember in the late war that the mind instinctively falls back upon a card index and a corps of clerks. It behooves us to remember! It's worth recalling some of the unpleasant, disagreeable and atrocious things done by the Germans in this war, if for no other reason than to preserve our balance when the whining and bluffing and mock heroics are indulged in. MR. FRANK H. PROBERT, who recently visited Europe for the Bureau of Mines, traversed the iron-bearing areas of Nancy, Briey, Longwy and Luxemburg, and the coal-bearing regions of Saar and Pas de Calais. He returns with the same story of frightfulness which impresses all who have had an opportunity for personal inspection of those districts.

MR. PROBERT says:

"The mines are not seriously crippled, but what of the steel plants in which the iron ore was smelted? No such atrocity was ever perpetrated against the industrial life of any country. Magnificent plants, comparing favorably with anything we have in the United States, are now but a tangled, twisted mass of structural steel and broken stone. The willful demolition was scientifically planned and systematically carried out. This after the removal of all such mechanical and electrical power units as could be used in Germany. The maliciousness and efficiency with which this crime

against French industry was conducted is almost unbelievable."

So much for the iron and steel industry. Of the French coal fields MR. PROBERT says: "The coal measures are overlain by water-bearing strata, necessitating special methods of shaft sinking and support to keep the mines dry. The steel lining of the shafts was dynamited, letting in the quicksands and flooding the underground workings for many miles. In the entire Pas de Calais region it is estimated that 120 million cubic meters of water must be pumped before mining operations are resumed. Having flooded the mines, the headframes and surface equipment were systematically dynamited, the twisted débris in many cases filling up the demolished shafts. It will probably be five years before this coal district can be rehabilitated and twelve to fifteen years before it gets back to normal pre-war output."

And in contrast to these conditions, the coal industry in the Saar is at the height of production! Meantime Germany calls upon us in the name of humanity, consience, justice—qualities which she has never shown—to have regard for her pitiful estate. The thing which most concerns us now is to stand firmly by the terms of a treaty which has been fairly drawn.

An Opportunity for Co-operative Research

ELSEWHERE in this issue we publish a letter from the Director of the Bureau of Standards calling attention to the decision of the Bureau to devote the sum of $10,000 to research in electroplating. While a good start will be made with this amount, it is apparent that much larger sums should be available in order to prosecute the work vigorously. At the moment we can think of no more appropriate donors of funds than those who would profit most from the results, viz., the electroplaters, and we take advantage of the opportunity to suggest an organization in their ranks for co-operative industrial research.

We speak not unkindly of our friends the electroplaters when we say that the impression prevails that their art has been based on rule-of-thumb development and secret formulæ rather than on scientific investigation and knowledge. Studies made during the war disclosed some fearful and wonderful solutions and "dopes," and brought to light methods and processes as archaic as they were unreasonable. On the other hand, some of the war tasks imposed on electroplaters showed them capable of getting remarkable results.

Our thought is that electroplaters can profit in a marked degree if they will get together and support a research into the fundamentals involved in their business. There is a fertile field of metallurgy, electrochemistry and physics in their art that would respond quickly to cultivation. There is no need to fear disclosure of trade secrets, many of which, by the way, probably would be found valueless; nor would the incentive to private initiative be removed, or the profits from superior skill be lost. These things are aside from the scientific groundwork of the art which would be investigated and elucidated for the benefit of all concerned. A few years of work by enthusiastic men who are now available would contribute more to the advancement of electroplating than anything we can think of, and the cost would be nominal when divided among the large concerns in the industry.

Scholarships In Sweden

WE TAKE pleasure in printing elsewhere in this number the announcement of ten scholarships available for American students in science to continue their studies and research in Sweden, with the information that ten similar scholarships of $1000 per year each have been provided for Swedish students to study in the United States. The American-Scandinavian Foundation of New York has secured the benefaction.

Of course we shall welcome the Scandinavian students here. We are glad to have them come, and hope they may find the enlightenment they desire in our various institutions. We are especially interested, however, in the opportunities for American students in Swedish universities and technological schools. For many years they have been addicted to good scientific habits in that country, and their teaching methods are at once thorough and sound. We have examples of this in PROFESSORS KENDALL of Columbia and TAYLOR of Princeton, both of whom started physical chemistry with no less a person than ARRHENIUS. Who wouldn't like to study physical chemistry under him!

Of course there is the language problem to be met by the stiff American tongue which adjusts itself with remarkable unwillingness to anything but "plain United States," but what with Polish and Russian and all the other Slavonic languages that claim attention, and the admitted requirements of French and Spanish, we see gala days ahead for the language teacher. Swedish should not be more difficult than German, which most of us engaged in science have tackled at one time or another.

The advantages of study in Sweden are peculiar, and students should profit by sojourning in communities in which certain things are better managed than at home. Thus the Swedes know how to take care of their forests, which we do not. Or, if we do know how, we do not put this knowledge into public practice, which is even more inexcusable than ignorance would be. Again, while we have pulp and paper mills that are remarkable examples of applied science, it is a fair guess that, taken by and large, there is better chemical control of this industry in Sweden than in the United States.

In the safety-match industry, although it was imported from Sweden, we turn out better material than do they at present, but we do not know where the better technology may be found. In applied electrochemistry they are well advanced, both in Sweden and Norway; a development which has followed their abounding water-power resources and the native disposition toward research.

They are grand metallurgists, and without attempting to make comparisons, it would be a great opportunity to study the subject in Swedish institutions. The same may be said in relation to pure science, more particularly physics and physical chemistry. Their methods are thorough; they take time enough to avoid the slapdash ways of some of our own institutions, and they have ideals of professional responsibility in science.

Granted the requisite character, intelligence and assiduity on the part of the ten young men to be chosen and to whom the opportunity of study in Sweden is offered, we think them lucky. If they come back to us speaking from their chests like some men from England engaged in an unfamiliar tongue, it will not confuse their speech. If they bring back legends of BEOWULF,

if they become inspired with Ynglinga Saga, if they repeat stories of GUSTAVUS ADOLPHUS and the Tenth and Twelfth Kings CHARLES and draw strange and exotic distinctions between hats and caps, it will do them no harm. And these things may lighten the idle hours of the rest of us. Such a Swedish slant will have a greater value in cultural influence than the convictions which in times past were sometimes brought back to the effect that the origins of righteousness and truth were centered in FREDERICK the Great and OTTO VON BISMARCK.

Cinematic Micrography

THOSE who have had the privilege of seeing the remarkable motion pictures of alternating stress failure exhibited by PROF. H. F. MOORE at the Society for Testing Materials or elsewhere during the past few months were greatly impressed by this recent application of the ubiquitous "moovies." Many of them were already familiar with the application of cinematography to motion study, where its possibilities have not even yet been fully exploited by scientific managers. In conjunction with the microscope, however, it remained for PROF. ARTHUR G. ELDREDGE of the University of Illinois to overcome the apparent difficulties which halted less intrepid investigators.

The layman could not dream of the possibilities of these well-known instruments, the motion camera and the microscope, even singly. Science is far too oblivious of their potency, especially in combination. Add the resources of the ultra-microscope and the ultra-visible rays, and the motion camera appears to be the key whereby the gate to vast areas of research may be opened. The outlook should be very attractive to educational and research institutions, and might well be the animus for revamping the all too meager photographic equipment they commonly possess.

PROFESSOR ELDREDGE'S brief discussion of the elementary principles underlying cinematic micrography appearing elsewhere in this issue should therefore be very interesting to research men, and it is hoped that this important contribution may result in many applications of such a powerful tool to future investigations of chemical and metallurgical engineering problems.

Government Control Of Markets

ONE hears very much less argument these days in favor of "government ownership" or "government control" of anything than was heard one short year ago, or even six months. Zealous JOHN WANAMAKER, when Postmaster General, explained that there were four reasons why the United States did not have a parcels post, those four reasons being the Adams Express Company, the United States Express Company, the American Express Company and the Wells-Fargo Express Company. The public now has several reasons why it does not favor government operation of utilities, among those reasons being government operation of the cables, of the Postal Telegraph-Cable Company, the Western Union and the railroads.

Better than all these reasons, however, because wartime necessity obtrudes itself when one endeavors to extract the essence, is the manner in which the Industrial Board program of "price deflation" or "price stabilization" worked out, for in it one is furnished the C. P. essence of the Washington politico-bureaucratic method of doing things and not accomplishing results.

Wordy as were the exchanges between the Industrial Board and the Railroad Administration before the former resigned, May 9, the remarks afterward made to the public by parties to the controversy quite outclass them. MR. PEEK announced—to the public—that "the public" would demand an explanation why the Industrial Board plan had been wrecked "apparently on the obstinacy of a single individual"—the Director General of Railroads—when "in theory the plan had been approved almost unanimously." Then MR. PEEK rapped the Secretary of the Treasury for taking "a stand in direct contradiction with his message urging the creation of the board." Finally he indicates the point of debarkation for the Attorney General by observing: "The Attorney General has rendered an opinion that the plan of the board contravenes the Sherman act, but the facts he assumes as the basis of that opinion are so inconsistent with the actual course of conduct of the board as to render the opinion inapplicable." To all or much of which the Secretary of the Treasury replies in a public statement that the Industrial Board "was hopelessly committed to an unsound and dangerous policy" and that "there is scarcely one accurate assertion or sane deduction in all the intemperate screed."

MR. PEEK had condemned himself in his statement. He asserted, which was true, that "in theory the plan had been approved almost unanimously," which obviously suggests that there must have been something wrong with the board's method of carrying out the theory, and so there was. The idea was that the board should act as an intermediary between seller and buyer, whereas it agreed only with the sellers and then sought to force the Railroad Administration to accept the terms, which the Railroad Administration refused to do. A function of the board was to be that of restoring the play of the law of supply and demand, but as a means of doing this it endeavored to fix steel prices for a period of nine months!

All these men were very likeable chaps before they went to Washington and got to doing things in a Washington atmosphere, which is the main reason why government operation of anything is to be avoided when it can be.

The Industrial Board acquired a misconception of the fundamental facts in the case, arrived at an improper conclusion, and then made it a personal issue to have others adopt its views. It was deceived as to the cost of making steel, accepting as applicable to the future certain statements of cost which included a heavy overhead because figured upon light operation of mills. The Industrial Board plan, however, contemplated the restoration of activity, and if that occurred the overhead would be much better distributed and the cost of production would be correspondingly lower. The steel producers, who know their market quite well, had no faith in an immediate resumption of constructional activity, and on that basis the reductions they accorded the Industrial Board must be considered large. Now the board is gone and the steel producers doubtless wish they had their old prices back again. And after all the wordy arguments of the past few weeks it is at last developed what the Railroad Administration would like to buy—200,000 tons of rails. That is one-fifteenth of one month's full output of finished steel.

Readers' Views and Comments

Economics in the Zinc Industry

To the Editor of Chemical & Metallurgical Engineering

SIR:—I certainly agree with the gentleman who wrote the article entitled Economics in the Zinc Industry in your issue of March 15, 1919, that roasting plays an important part in the smelting of zinc ores and that there is considerable room for improvement in the roasting of ores for the extraction of zinc, more especially with respect to the design of the roaster. From all the results and experiments I have made on samples from the kilns during the process of roasting, the indications are that sulphides do not pass by degrees to sulphates and then to oxides, but more directly to oxides. If this were not the case a greater percentage of the sulphates would be found at certain places along the bed of a mechanical roaster or at certain periods in hand-roasting.

The following results obtained on a hand-rabbled kiln show a low percentage of sulphates at all periods:

CHEMICAL DISTRIBUTION OF SULPHUR IN HAND-RABBLED KILN

Test No. 1

	SiO_2, Per Cent	Fe, Per Cent	Zn, Per Cent	Pb, Per Cent	Total S, Per Cent	Soluble Sulphates: Sol. H_2O S, Per Cent	Soluble Sulphates: Basic Sulphate Sol. Na_2CO_3 S, Per Cent	Sulphide S, Per Cent
Crude	1.8	10.7	47.1	5.2	33.8	0.066	0.08	33.65
Crude at 8:30	2.0	10.7	46.4	5.3	33.6	0.055	0.07	33.48
9:30 1st hour	...	....	....	...	28.8	0.1	0.01	28.65
10:30 2nd hour	...	....	....	...	26.7	0.077	0.077	26.55
11:30 3rd hour	...	....	....	...	22.4	0.11	0.15	22.14
12:30 4th hour	...	....	....	...	20.0	0.11	0.11	19.78
1:30 5th hour	...	....	....	...	17.2	0.13	0.21	16.86
2:30 6th hour	...	....	....	...	11.4	0.28	0.33	10.79
3:30 7th hour	...	....	....	...	8.8	0.14	0.23	8.43
4:30 8th hour	...	....	....	...	5.1	0.14	0.23	4.73
5:30 9th hour	...	....	....	...	1.9	0.19	0.31	1.40
6:30 10th hour	...	....	....	...	1.2	0.33	0.46	0.41
7:30 11th hour	...	....	....	...	0.9	0.30	0.47	0.13
8:30 12th hour Finished	7.4	11.8	53.1	3.5	0.9	0.38	0.44	0.08
Roasted ore	7.4	12.3	52.5	3.4	1.5	0.37	0.45	0.68

Test No. 2

	SiO_2, Per Cent	Fe, Per Cent	Zn, Per Cent	Pb, Per Cent	S, Per Cent	Soluble Sulphates: H_2O S, Per Cent	Soluble Sulphates: Na_2CO_3 S, Per Cent	Soluble Sulphates: Total S, Per Cent	Sulphide S, Per Cent
Crude ore	1.6	10.4	46.7	5.5	34.0	0.066	0.11	0.18	33.82
9 a.m.	1.6	10.3	46.7	5.6	33.8	0.044	0.11	0.15	33.65
10 a.m.	...	....	....	...	27.5	0.12	0.12	0.24	27.26
11 a.m.	...	....	....	...	20.9	0.11	0.27	0.38	20.52
12 m.	...	....	....	...	23.6	0.12	0.25	0.37	23.23
1 p.m.	...	....	....	...	16.2	0.12	0.34	0.46	15.74
2 p.m.	...	....	....	...	14.6	0.14	0.33	0.47	14.13
3 p.m.	...	....	....	...	9.6	0.14	0.38	0.52	9.08
4 p.m.	...	....	....	...	6.7	0.10	0.33	0.43	6.27
5 p.m.	...	....	....	...	1.8	0.11	0.33	0.44	1.38
6 p.m.	...	....	....	...	0.94	0.11	0.46	0.57	0.37
7 p.m.	...	....	....	...	0.66	0.12	0.46	0.58	0.08
8 p.m.	...	....	....	...	0.66	0.13	0.52	0.65	0.01
9 p.m. Roasted ore	1.6	11.8	54.8	3.3	0.94	0.26	0.51	0.77	0.17
General sample roasted ore	1.6	12.0	54.8	3.5	1.65	0.26	0.52	0.78	0.67

Test No. 3

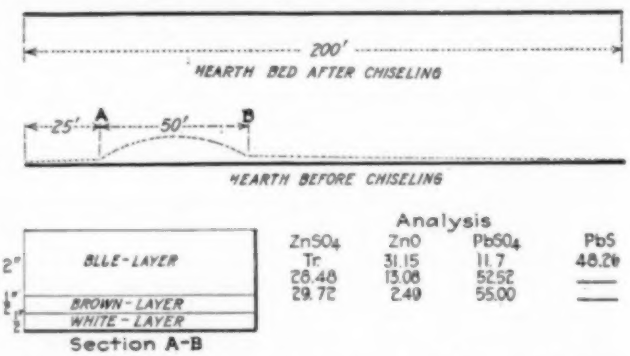
	SiO_2, Per Cent	Fe, Per Cent	Zn, Per Cent	Pb, Per Cent	S, Per Cent	Soluble Sulphates: H_2O S, Per Cent	Soluble Sulphates: Na_2CO_3 S, Per Cent	Soluble Sulphates: Total S, Per Cent	Sulphide S, Per Cent
Raw ore	1.6	10.2	46.8	5.7	33.8	0.055	0.10	0.16	33.64
Crude ore:									
11 a.m.	1.6	10.2	46.7	5.7	34.3	0.044	0.11	0.15	34.15
1 p.m.	...	....	....	...	19.5	0.76	1.17	1.93	17.57
3 p.m.	...	....	....	...	17.6	0.15	0.37	0.52	17.08
5 p.m.	...	....	....	...	16.6	0.15	0.34	0.49	16.11
7 p.m.	...	....	....	...	12.8	0.13	0.39	0.52	12.28
1 a.m.	...	....	....	...	2.9	0.11	0.56	0.67	2.23
3 a.m.	...	....	....	...	3.2	0.18	0.65	0.83	2.37
5 a.m.	...	....	....	...	2.3	0.25	0.78	1.03	1.27
7 a.m.	...	....	....	...	1.1	0.15	0.81	0.96	0.14
9 a.m., 2nd and 3rd	...	....	....	...	1.4	0.23	0.87	1.10	0.30
Finished 11 a.m., 2nd and 3rd	1.6	11.3	53.4	5.0	2.5	0.72	1.19	1.91	0.59
Roasted ore, general sample	1.6	11.6	53.4	5.0	3.1	0.72	1.17	1.89	1.21

Test No. 4

	SiO_2, Per Cent	Fe, Per Cent	Zn, Per Cent	Pb, Per Cent	S, Per Cent	Soluble Sulphates: H_2O S, Per Cent	Soluble Sulphates: Na_2CO_3 S, Per Cent	Soluble Sulphates: Total S, Per Cent	Sulphide S, Per Cent
Crude, 9:45 a.m.	1.6	10.0	46.9	5.8	31.9	0.09	0.06	....	31.75
Roasted ore, 9:45 p.m.	4.6	11.8	55.6	2.4	0.6	0.2	0.29	....	0.11
Do	4.4	11.8	55.6	2.3	0.7	0.22	0.34	....	0.14

The following results show that the formation of sulphates is very slow and that the oxide of zinc and the sulphide of lead are changed to sulphates, and apparently without the action of much air or rabbling. These samples represent what is called the kiln bottom, and were taken from a Ropp roaster as shown by the sketch.

As the ore is moved forward by the rabble plows, the heavy galena entangled with a certain amount of zinc and iron sulphides is deposited between *A* and *B*, and



gradually grows or builds up to a thickness of from 6 in. to 10 in., when it has to be chiseled out. From the above experiment the indication would be that a thick bed moving slowly through the kiln is a better condition for roasting ores for electrolytic production of zinc than where the distillation process is used; and where the latter process is to be used the roasting kiln should be designed to give an instantaneous roasting condition as near as possible.

In 1913 the writer made the following experiment: A piece of tile 5¾ in. by 9 in. was covered with as thin a layer of ore as possible. The ore was then brushed off and weighed. The tile was then inserted into an assay muffle and heated to a good red heat, when it was withdrawn, and the weighed ore quickly spread over, and the tile with ore reinserted into the muffle. The following results were obtained:

	Green Ore Taken, Grams	Time in Muffle, Min.	Per Cent Sulphur
Joplin ore	45	10	2.80
Joplin ore	45	15	1.50
Western ore	45	10	4.07
Western ore	45	15	0.70

Now, as the amount of ore taken was 45 g. and the area of the tile was approximately 50 sq.in., there would be 0.9 g. per sq.in., or 129.6 g. per sq.ft. Taking the area of a regular kiln at 2250 sq.ft., we would have, if the ore were spread over the hearth as in the test, 2250 × 129.6, equal to 291,600 g.; or, dividing by 454, the number of grams in one pound, we would get 642 lb. of roasted ore every 15 min., which is equivalent to 61,632 lb. per 24 hr., based on green ore. This would be considered very good in actual practice. So far as the chemical reactions, heat and air are concerned the principle seems ideal, and it is only a matter of

working out the mechanical details of a suitable kiln. After making this experiment I concluded that a revolving hearth would be best suited to accomplish an instantaneous roast and went so far as to design one and apply for a patent, when I discovered that Mr. Wilfley had already covered the ground. As Mr. Wilfley had not followed up the subject with the installation of a practical roaster on a commercial scale, so far as I knew, I lost interest in the matter. It would be of interest, however, to learn from Mr. Wilfley his experience with the small roaster he built and tested, and whether he thinks there are possibilities along this line.

Henryetta, Okla. E. M. JOHNSON.

That Missing Page From the Blue-Back Speller

To the Editor of Chemical & Metallurgical Engineering

SIR:—Referring to your article "That Missing Page From the Blue-Back Speller" on page 794 of your issue of Dec. 15, I think your question as to the wisdom of adding cold solid additions in the ladle in making steel is pretty well answered by the fact that the steel should be poured at a temperature only very slightly above its liquidus or upper freezing point. Thus the casting temperature should be so low that a considerable skull is often left in the ladle. Moreover, pouring at a temperature materially above the liquidus causes external cracks on the sides of the ingot, from the fact that the rate of thickening of the solid walls of the ingot goes on so slowly as the column of molten steel rises that the ferro-static pressure becomes so great as to crack these walls. Under these conditions the margin of temperature between the freezing point and the existing temperature of the molten steel is so slight that the melting of any solid additions must be relatively slow. The last particles of the addition cannot begin to diffuse or to be spread by convection until they have actually melted. Indeed the molten steel has so slight a margin of temperature above its solidus that large quantities of it may be expected immediately to freeze about any cold solid ferromanganese that is thrown into it, quite as when one thrusts a cold iron rod into a pot of molten glass one will draw out a bunch of glass which may be much thicker than the rod itself. We shall thus have a mass consisting, first, of the cold ferromanganese, and, second, of an envelope probably many times larger than the manganese itself of plastic steel which has solidified about it. The melting of the manganese cannot begin till the whole of this resolidified steel has melted, and the diffusion of the whole of the manganese cannot begin till still later, when the last of the ferromanganese has melted.

Moreover, because the temperature is so much lower in the ladle than in the furnace, the activity of the manganese in removing the oxygen is materially less. This is no doubt the important reason why the loss of manganese is less when it is added in the ladle than when it is added in the furnace.

Actual practice shows that this is not an imaginary condition. In fact when manganese is added in the ladle it has been observed in many cases that the last ingot poured is materially richer in manganese than the first, indicating either that the manganese has been floated to the surface by means of the envelope of steel resolidified about it, or that there have been in effect successive additions of manganese to the molten metal by the successive meltings of the different lumps of ferromanganese, each surrounded with its own envelope of resolidified steel. As each became free from its envelope and in turn melted, it would become added to the molten metal and would no doubt diffuse rapidly through it. Hence the last ingot may be much richer in manganese than the first.

I have had the advantage of discussing this matter with Colonel Barba since reading your article, and I believe his recommendations represent not simply his own opinion, but the result of experience and widespread belief. H. M. HOWE.

Washington, D. C.

Work of the Bureau of Standards on Electroplating

To the Editor of Chemical & Metallurgical Engineering

SIR:—As was stated in January in the *Monthly Review* of the American Electroplaters' Society, efforts were made to secure from Congress a small special fund for work in this field. Owing to the many demands upon Congress at that time, it was not possible to secure this or numerous other special funds requested by the Bureau. However, in view of the importance of electroplating to many industries, and of the advantage of continuing the investigations now in progress, it has been decided to make an allotment of $10,000 for this work from the Industrial Research Fund recently appropriated to the Bureau for the year beginning July 1, 1919. Reports upon the progress and results of this work will be published from time to time in this and other technical journals, and in Bureau publications.

Even with the annual expenditure of this sum, it will require a considerable period to study the many kinds and problems of electroplating. More rapid progress could no doubt be made if additional funds were available. If, therefore, the platers or manufacturers interested in electroplating desire to contribute to the support of this work, preferably through the American Electroplaters' Society, satisfactory arrangements can no doubt be made. Such support might either take the form of annual subscriptions from firms, or of the employment by firms themselves of persons to work at and under the direction of the Bureau of Standards upon some problem of general interest. In the latter case the facilities of the Bureau could be employed with the understanding that all the results of such work would be made available to the public.

In order to make this work of value to the industry, it is important that in the future, as in the past, we should receive the active support and assistance of the electroplaters, who are, therefore, encouraged to send to the Bureau information possessed by them, and requests for information desired by them.

Bureau of Standards,
Washington, D. C. S. W. STRATTON,
Director.

Decomposition of Metals

To the Editor of Chemical & Metallurgical Engineering

SIR:—In my article on "Decomposition of Metals" in your issue of April 15, 1919, there was an error on page 423, first column, first line. The last part of the sentence should read: "we might expect a transformation of β crystals into brittle γ crystals to occur in certain brasses under certain conditions." The sentence as printed had α crystals instead of γ crystals.

Bureau of Standards,
Washington, D. C. A. I. KRYNITZKY.

The Oxidation of Ammonia

AT THE May 8 meeting of the Washington Section of the American Chemical Society Dr. Charles L. Parsons presented an interesting paper on the oxidation of ammonia. A brief résumé was first given of European work along this line including a description of the Ostwald process and of the Frank-Caro process. The Ostwald process was first put into commercial operation at Gerthe, Westphalia, in 1909, and later at Vilvorde, Belgium. During the war plants using this process were operated at Angonleme, France, and Dagenham, England. After the beginning of the war in 1914 the Frank-Caro process was developed by the cyanamide interests of Germany and this process was used in the huge German plants later built. It is a matter of surprise that there appeared in the January, 1916, issue of *Metall und Erz* a detailed description of the Frank-Caro process as then developed.

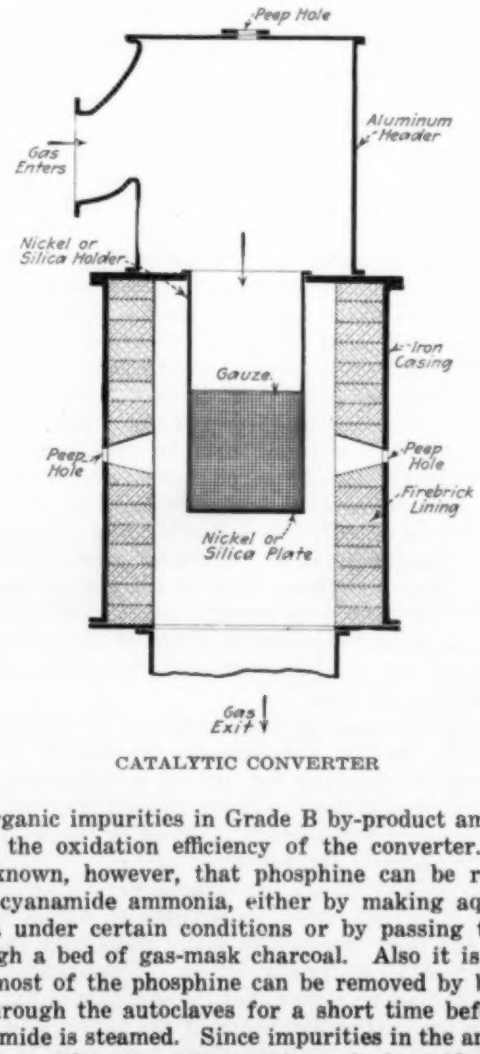
The Frank-Caro apparatus used a flat platinum gauze as a catalyst to promote the reaction in the air-ammonia mixture. The American prototype of this flat gauze converter is the Landis converter of the American Cyanamid Co., first used at Niagara Falls early in 1916, later at Warner's, N. J., and finally installed in the large U. S. Nitrate Plant No. 2 at Muscle Shoals, Ala. The installation at Muscle Shoals has been described by Fairlie in CHEMICAL & METALLURGICAL ENGINEERING, Vol. 20, No. 1, page 8, Jan. 1, 1919.

In August, 1916, the Bureau of Mines entered into a co-operative investigation of ammonia oxidation with the Semet-Solvay Co. Under this arrangement there was put into operation several months later, at the Semet-Solvay's plant near Syracuse, N. Y., a converter of the Landis type using a flat platinum gauze approximately 1 x 2 ft. as a catalyst. The primary purpose of this installation was to determine whether by-product coke-oven ammonia could be oxidized readily by means of such a converter. The apparatus worked well, running on the Semet-Solvay "Grade A" by-product ammonia with high efficiency. The consumption of electrical power for heating the gauze was, however, considerable, and appeared unnecessary in view of the large amount of heat liberated by the oxidation reaction itself. The design of a converter in which the heat developed by the reaction should be utilized to maintain the necessary gauze temperature was therefore undertaken.

It had been noted that the flat gauze converter would operate without electrical heating on a 10 to 12 per cent ammonia-air mixture, but with a lowered efficiency, due apparently to too low a gauze temperature. By simply using three layers of previously activated gauze it was found that fairly high efficiencies would be reached without electrical heating. It appeared, however, that the gauze temperature was still somewhat too low. Attention was then turned to a new design of apparatus in which the previously activated gauze was rolled into a cylinder and supported concentrically in a brick-lined cylindrical casing. One end of the gauze cylinder was closed with a quartz or nickel plate. The air-ammonia mixture was forced in at the other end of the gauze cylinder and passed out through the four layers of gauze forming the cylinder wall. By this arrangement the heat generated by the reaction was conserved to such a degree that a satisfactory operating temperature was maintained in the gauze.

The air-ammonia mixture, containing about 10 per cent of ammonia, is delivered at the top of the converter through an aluminium pipe. The reaction is initiated at the gauze by projecting a small flame against it for a moment until the oxidation reaction starts. The glow soon spreads over the whole gauze. The hot gases leaving the gauze impinge on the brick lining of the outer casing and bring this up to near red heat, so that considerable heat is radiated back onto the gauze. After being put into operation the apparatus requires no further attention. A converter of this type was operated continuously at the Semet-Solvay's plant from February to September, 1918. It was shut down on the latter date only because an inexperienced plant operator allowed caustic solution to back up into it. On a 23-day test run with one of these converters at Syracuse in 1918, an average of 160 efficiency determinations gave 90.7 per cent.

The platinum gauze used is woven of 0.0026-in. diam. wire, 80-mesh per linear inch, and weighs approximately 16⅓ ounces. The converter is operated with a gas flow of 200 cu.ft. per minute, representing a capacity of about 2⅓ tons of nitric acid (figured as 100 per cent acid) per day. The gauze must be kept free from iron oxide, oil and the like. Impurities in the gas, such as the phosphine in cyanamide ammonia, or



CATALYTIC CONVERTER

the organic impurities in Grade B by-product ammonia, lower the oxidation efficiency of the converter. It is now known, however, that phosphine can be removed from cyanamide ammonia, either by making aqua ammonia under certain conditions or by passing the gas through a bed of gas-mask charcoal. Also it is known that most of the phosphine can be removed by blowing air through the autoclaves for a short time before the cyanamide is steamed. Since impurities in the ammonia gas lower the gauze temperature, it is evident that either preheating the gas by means of the waste heat

of the reaction or adding electrical heat to the gauze will result in higher efficiency when oxidizing an impure ammonia. The converter operates normally at about 825 deg. on a 10 to 11 per cent ammonia-air mixture. In general the oxidation efficiency at a given gauze temperature is inversely proportional to the percentage of ammonia, but the cylindrical gauze converter will not operate well with much less than 10 per cent ammonia in the gas mix unless a preheater is used. In preheating the air-ammonia mix, the preheater must be so designed that only nickel, aluminium or silicate parts are in contact with the hot gas, for other material decomposes the ammonia.

The cylindrical gauze converter as developed by the Bureau of Mines was slightly modified by the Ordnance Department and installed in U. S. Nitrate Plant No. 1. The results obtained with the converter at this plant, being Ordnance Dept. records, Dr. Parsons was, unfortunately, not at liberty to discuss.

As the last item in his paper Dr. Parsons presented a graph showing the cost of producing nitric acid from Chile nitrate as compared with its production by the oxidation of ammonia and subsequent conversion of the nitrogen oxides to nitric acid of various concentrations. The interesting point was made that, on the basis of the estimates represented, a 94 per cent nitric acid could be made by the ammonia oxidation process (with subsequent concentration) in competition with nitric acid from Chile nitrate when the price of Chile nitrate was 2c. per lb. and cost of producing ammonia 11½c. per lb.; likewise the cost of 50 per cent nitric acid would be the same from the two processes when Chile nitrate cost 2c. per lb. and ammonia 14c. per pound.

Modern Training of the Chemical Engineer

AT A meeting held at the College of the City of New York under the auspices of the College Chemical Society, April 25, Dr. Ralph H. McKee, professor of chemical engineering of Columbia University, presented a paper dealing with certain phases of chemical engineering education, particularly with recent changes in the curriculum.

We may define the scope of a chemical engineer's work by saying that he applies knowledge obtained from the field of pure science and from the field of engineering to the solution of the problems of applied chemistry. Due consideration must be given to the financial element, so that the solution may be commercially practicable.

A process must go through several stages before it becomes a part of chemical industry. After leaving the laboratory, the process is developed in a small-scale plant. If successful, a full-sized plant is next constructed and operated by partially skilled labor, after having been trained by the technical staff. Following the initial operating period, refinements in the process are made by the chemical engineer.

Some fifteen years ago, when chemical engineering was in its infancy, there was considerable discussion as to whether the training of a chemical engineer should be primarily along engineering lines and only secondarily chemical, or vice versa. A number of the larger universities took the former attitude, but at the present time it is conceded that the emphasis should be placed upon the chemical training. It is essential that the instructors should be familiar with actual practice and should not have to rely on text-books. It has been said that text-books of industrial chemistry are mostly descriptions of methods that are obsolete. This statement was made twenty years ago, but it is even more true today. The Chemical Warfare Service took on an average three months to develop a new process and by that time the process was often obsolete. Of course, this work was done under the stress of war-time necessity, but it is, nevertheless, an indication of the changes which are constantly taking place in the industry.

In industries of a mechanical nature, production costs may be distributed approximately as follows: Labor, 35 per cent; materials, 35 per cent; overhead, 30 per cent; while for a chemical plant the cost of labor may vary from 12 per cent to as low as 1 per cent; materials, up to 90 per cent; overhead, in some cases 30 to 35 per cent. It is evident that in the chemical industries, efficiency of operation and maximum output are the main factors governing cost of production. A 3 per cent increase in yield may be equivalent to cutting the labor cost in two.

While the cost of labor is not a major item, labor itself is exceedingly important. The technical force should be well paid and the laborers should be fairly intelligent, as carelessness on their part may result in large losses of valuable materials. Carefulness and willingness of workmen to follow instructions are more important than education. It is interesting to note the possibilities which may result from the employment of psychological tests, such as have been used in the United States Army, in the selection of labor.

Twenty years ago, the chemical engineer studied general chemistry, qualitative and quantitative analysis (including assaying) and text-book work only in metallurgy, organic and industrial chemistry. Ten years ago, physical and electro-chemistry were added to the list, emphasis being placed upon the theoretical treatment of these subjects. At the present time the tendency is to increase the time devoted to laboratory work in the general, organic, physical, electrochemical and industrial chemistry courses, and to cut down the work in qualitative and quantitative analysis, metallurgy and the classroom work in physical chemistry. Assaying is generally omitted. During this same period, in connection with the other college courses, there has been a decrease in the amount of drawing and mechanical engineering required, and civil engineering has been largely eliminated. In their place we find heavier courses in physics, a study of business law, contracts, specifications, etc., and certain phases of biology, such as the utilization of bacteria, yeasts and molds which are capable of producing chemical transformations.

Since there are different requirements for chemical engineers, there should be different kinds of chemical engineers. With this object in view, the present graduate courses in chemical engineering at Columbia University have been chosen primarily for the purpose of training men who may become superintendents and managers of plants, and less for work in industrial research laboratories. The phases of the work given at Columbia but not customarily given in undergraduate curricula of chemical engineering are the following:

1. Chemical factory machinery, including plant construction and apparatus layout.
2. Applied colloid chemistry.
3. Factory wastes disposal.
4. Plant management, including problems relating to

labor, insurance, laws governing dangers, compensation, etc.
5. Efficiency engineering.
6. Laboratory courses using standard semi-factory size equipment.
7. One summer vacation period of eight weeks must be spent by the student in a factory as a laborer in order that he may be able to understand the workman's point of view.
8. In the third year, the student takes up a research problem of a factory type.

So far as I know no university teaches its engineering students the handling of labor and employment. The indications are that these subjects may be satisfactorily taught in the class-room. We at Columbia are trying to work out a method of handling these subjects but we have not yet quite reached the stage where we are ready to offer such courses to our chemical engineering students. Army experience has shown the value of psychological tests, and experiments in scientific labor employment in several factories have proved successful. In one plant employing 6000 persons, it was found necessary to hire 15,000 in 1917, so that the labor turnover was 2½. After the introduction of psychological tests, a report showed that the excess labor amounted to only 3000 per annum, or a labor turnover of 1½. Since it costs from $75 to $300 to break in a new man, depending upon the nature of the work, the importance of reducing labor turnover to a minimum is apparent.

American Scientific Glass

AT the meeting of the New York section of the American Chemical Society, May 9, a symposium on Scientific Glass was held. Harrison E. Howe of A. D. Little, Inc., read the leading paper, in which he reviewed the developments beginning with the work of Fraunhofer, Faraday and Harcourt and through the classical researches of Ernst Abbe and O. Schott at Jena. Since an account has recently been published[1] covering similar ground, only brief mention will be made of some of the new features brought out.

The plate glass slab rolling method has been successfully applied, which facilitates grinding and selection of suitable lens pieces. Motor-driven stirring apparatus has been adopted in place of hand stirring. It is necessary to have sand with less than $\frac{1}{200}$ per cent iron content. Phosgene treatment costs $40 per ton and only removes the iron not sealed in the silica aggregates. The maximum limits of constituents are as follows:

	Per Cent.		Per Cent.
Silica	75	Baryta	50
Alkali	20	Zinc	12
Lime	15	Alumina	5
Lead	7	Boron	20

Dr. A. V. Bleiniger of the Bureau of Standards pointed out the future needs of the industry as being purer raw materials; better data, as there are many gaps in the present curves; a knowledge of annealing theory and a set of optical specifications. The glass pots developed by the Bureau are made of a mixture of open and dense burning clays obtained from Tennessee, Kentucky and Georgia. The resistance of the pot to slagging is due primarily to the closed dense surface of the pots giving a minimum area of reaction contact. Large ton pots are necessary in order to get the ratio of glass volume to pot contact reduced small enough to keep the slagged impurities concentration low enough.

Carl W. Keuffel stated that counter colors or bleaches could not be used because of the resistance to light transmission they set up in the glass. After last September more than adequate supplies of good glass were available—the glass manufacturers passed the instrument makers in the race.

Mr. Harry Rosenthal spoke of the recent celluloid-glass lenses which are not shatterable with a 2-ft.-lb. blow. Color absorbing, and matching glasses are readily made by dyeing the celluloid.

[1]Home-made Optical Glass, H. E. Howe, CHEM. & MET. ENG., Sept. 27, Vol. 19, No. 6d., Page 479.

American Institute of Chemical Engineers, Boston Meeting

THE eleventh semi-annual meeting of the American Institute of Chemical Engineers will be held in Boston, Mass., with headquarters at Lenox Hotel, from June 18 to 21, 1919. Following is the official program:

Wednesday, June 18, 1919.

9:00 A.M. Registration at Engineers' Club.
9:30 A.M. Welcome by the Mayor or his representative and response.
Business session.
10:00 A.M. Reading of papers:
Symposium on Electric Furnaces.
The Future of the Electric Furnace, C. T. Bragg, Mich. Smelt. & Ref. Co.
Utilization of Electric Brass Furnaces, H. W. Gillette, Bureau of Mines.
Problems Encountered in Electric Furnace Practice, P. E. McKinney, Washington Navy Yard.
Electric Furnaces of the Resistance Type—Ill. by motion pictures, T. F. Bailey, Electric Furnace Co.
12:30 P.M. Luncheon at Engineers' Club.
2:30 P.M. Reading of papers:
Symposium on Electric Furnaces continued.
Ajax Wyatt Induction Furnace—Slides, G. H. Clamer, Ajax Metal Company.
Some Practical Results Secured with High-Frequency Induction Furnaces, Dr. E. F. Northrup.
Booth-Hall Rotating Furnace—motion pictures, Carl H. Booth, Booth-Hall Co.
The Rocking Electric Arc Furnace, E. L. Crosby, Detroit Elec. Furnace Co.
8:00 P.M. Smoker in assembly room, Arthur D. Little, Inc., with inspection of museum and laboratories. The paper mill will be in operation, and arrangements made for special laboratory demonstrations.

Thursday, June 19.

9:30 A.M. Board tug for tour of inspection of industrial plants along Boston waterfront, Commonwealth and Fish piers, the largest fish-handling pier in the world.
Victory shipbuilding plant at Squantum.
Revere Sugar Refinery.
Buffet lunch, on tug.
Afternoon—Edison Power Plant.
New England Gas & Coke Co.
Trip by tug to Marblehead.
Dinner at Eastern Yacht Club.
Return to Boston by tug, train or auto.

Friday, June 20.

Meeting at Mass. Inst. of Technology.
9:00 A.M. Business meeting.
10:00 A.M. Reading of papers:
Growth and Development of the Manufacturing Plant of the Providence Gas Co., W. H. Russell.
Flash and Burning Points of Gasoline-Kerosene Mixtures, James T. Robson and James R. Withrow.

Chemists Should Be Registered and Licensed, Edward Gudeman.
State Licensing of Engineers and Chemists, James R. Withrow.
Chemists Should Not Be Licensed, A. W. Smith.

12:30 P.M. Luncheon at Walker Memorial, M. I. T.
1:30 P.M. Inspection of laboratories, Mass. Inst. of Technology.
Harvard University, including the Peabody Museum, the Wolcott Gibbs Laboratory of Research Chemistry, and the Jefferson Laboratory of Physical Research.
The Agassiz Museum, The Glass Flower Exhibit, will be open.
4:30 P.M. Historic Boston by sightseeing auto.
7:00 P.M. Dinner at Brookline Country Club.

Saturday, June 21.
All day excursion by train to Lawrence, Mass., for inspection of plants—Champion International Co. (paper) and some of the largest textile plants in the world, as Pacific Mills, Arlington Mills, American Woolen Co.
Return to Boston by train.

Surplus Government Supplies

Sodium nitrate will be sold for the War Department by W. R. Grace Co., Wessell, Duval & Co., and H. B. Baker Co. of New York City and the Du Pont Nitrate Co. of Wilmington, Del.

Sulphur will be sold by the Union Sulphur Co., New York City.

Copper will be sold by the United Metals Selling Co., New York City.

Alcohol will be disposed of, as far as possible, by supplying the needs of the other departments of the Government. Any surplus remaining after all of the bureaus have been amply provided for will be sold back to the producers.

Spring Meeting of the T. A. P. P. I.

The Association will convene Wednesday morning, June 11, at the Hotel Lawrence, Erie, Pa., for inspection trips to the plants of the General Electric Co. and the Hammermill Paper Co. Following a complimentary dinner by the latter company, the Association will leave Erie for Buffalo, where business and technical sessions will be held in the auditorium of the Larkin Co. Paper and pulp manufacturers on both sides of Niagara Falls have offered to open their plants for inspection. Details of these visits will be announced later. Henry F. Obermanns, Hammermill Paper Co., Erie, Pa., and Paul Kellogg, Larkin Co., Buffalo, N. Y., should be notified of the intention to attend.

Chicago Meeting A. I. M. E.

The American Institute of Mining and Metallurgical Engineers will hold its Fall meeting in Chicago, Sept. 22 to 26. This meeting promises to be one of decided importance to the industry, as subjects of vital concern will be under discussion. In addition to the technical talks, an elaborate social programme is being arranged, and excursions by the Institute as a body are planned to many points of interest in the vicinity, including the steel mills at Gary, the oil refineries at Whiting, metallurgical plants at East Chicago and North Chicago, and to the LaSalle district, where the cement, coal and zinc industries are represented.

Industrial and Academic Co-operation

THE much heralded co-operation between industry and technical schools is rapidly becoming a fact. Good evidence of this was shown in Brooklyn at the annual dinner of the Polytechnic Institute Alumni Association and the Chemical and Engineering Societies on May 10. Dr. John C. Olsen was toastmaster and had a complete stock of wit on tap which compensated for the way the wine and Scotch was served, in cubes. Dr. F. W. Atkinson reviewed the progress of the institution, which has grown to 800 students. Eighty thousand dollars was received in donations during the past year, of which $35,000 was subscribed by Dr. William H. Beckers, vice-president of the National Aniline Co., for use in the chemical engineering laboratory. When Dr. Beckers was asked to tell how he managed to build up the large Beckers dye works in the face of German competition before the war, he said that independent American manufacturers could not use imported intermediates very well. His chief product was a blue dye resembling anthracene blue, but actually made of gallic extract and cymene. It was not a fast dye and the Germans quickly persuaded the trade to abandon it by demonstrating the comparative fastness of their anthracene, which was about forty times more fast. However, Dr. Beckers ultimately found out that his dye was good for four seasons' wear and so was able to get and hold onto a fair trade. Dr. Beckers' advice to the chemical alumni was to pick out one or two propositions and persistently stick to them until they were accomplished. To those who had been successful in business he said, "It is not enough that the wealthy trustees give their hundreds or thousands of thousands of dollars in endowments. They must co-operate in their technical work with the technical schools. Ample rewards should be liberally given for results accomplished.

Lt.-Col. Alfred H. White briefly outlined the operations at Muscle Shoals and had most excellent slides shown on the screen. Dr. Frederick de Jahn of the General Chemical Co. was called upon to tell about the G. C. process but preferred to say no more than that they were very successful. The finale was ingeniously worked out by Dr. Irving W. Fay. A large Old Glory was developed by blowing some of the G. C. synthetic ammonia on its once-believed-to-be-all-white-banner-by-the-über-alles-dye-makers-of-the-Rhine and true to form, the colors gleamed forth amid the closing song by the alumni of "The Star-Spangled Banner."

Exchange of American-Scandinavian Scholarships

The American-Scandinavian Foundation announces the establishment of 10 new scholarships beginning with the academic year 1919-1920 for young American scientific students who desire to complete their study and research in Sweden. Each scholarship will provide $1,000 for one year's study and the funds will be provided by Americans who desire to promote interchange of knowledge between the two countries. Similarly, funds are being raised in Sweden to send 10 Swedish students to the United States. Physics, chemistry, hydro-electric engineering and metallurgy are among the subjects offered. Applications will be acted upon by a committee and should be filed before June 1. Papers can be secured from the American-Scandinavian Foundation, 25 West 45th St., New York City.

Photography in Research

A Concise Review of the Applications of Photography in Industry—Illumination, Lenses and Appliances—Motion Microphotographs Record Stresses in Wrought Iron—Opportunities for Development

BY ARTHUR G. ELDREDGE

INDUSTRIAL organizations and educational institutions have for some time recognized the value of photography, its chief uses being for records, graphic proof on progress of work, or illustrations for lectures. Investigators would do well to follow in such footsteps, since in science there is absolutely no other means of adequately recording the facts. Words fail completely to portray conditions. Drawings can but poorly convey the texture, minute detail or substance of an object as it really is. Photography does swiftly, accurately and easily these things which by other means are done laboriously or not at all.

Modifications of the simple camera have a limit to their accomplishments. The next step is the microscope. What remarkable things it does for us! On the other side of the eyepiece there awaits a new world, things indescribable, impossible of delineation. Photography steps in, it accentuates color contrasts or eliminates them, it will record the facts for which you seek if used with skill. In the living sciences it reveals for the masses those secrets with which few are acquainted. In mineralogy it shows by polarized light rock structures we could not have guessed. (Figs. 1 and 2.) Modern metallurgical methods and products could hardly exist but for information revealed by the microscope. In this case photography can record the facts of structure and composition for quick comparison.

Surpassing all of these methods is the motion picture. In this instrument we have a tool outstripping the magic of Aladdin. It tells things we would not dare dream. It may prove beyond contradiction things beyond the wildest conjecture. Our eyes are something of a compensating instrument—they can interpret only slow motions, and by reason of the persistence of vision are a complete failure in splitting seconds. Not so the motion picture; with it consecutive pictures of a moving object may be made with exposures varying from one-fifth of a second to one ten-millionth of a second. Pictures taken at excessive speeds when projected at the normal rate of 16 exposures per second permit one to analyze the motions and to understand things entirely beyond ordinary vision.

In the field of research men are endeavoring to uncover the unknown, to do the "impossible," but are far too slow in adopting photographic methods. The moving picture and the microscope can see a million times quicker and smaller than the eyes. Unaided vision can recognize a two-hundredth of an inch, but not interpret it, while motions quicker than a tenth of a second run together: one cannot separate them. How, but for the microscope and photography, could we know the vast world beyond? It can show what is happening right down to the bare bones of matter and force.

LIMITATIONS OF OPTICAL LENSES

Many who read this may not be thoroughly familiar with the optics of an optical or photographic microscope, so some of the principles affecting this work will be noted briefly. In applying photography to the microscope we find certain exacting conditions and narrow limits in which to work; the laws governing numerical aperture, resolving power and wave length are inflexible.

In working with opaque objects the problem is much

FIG. 1. FELDSPAR BY ORDINARY LIGHT. × 100 IDENTICAL AREA AS IN FIG. 2

FIG. 2. FELDSPAR BY POLARIZED LIGHT, CROSSED NICHOLS. × 100

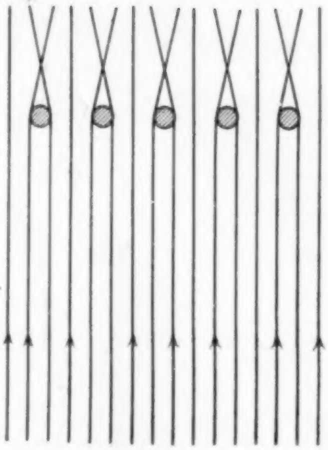


FIG. 3. EFFECT OF DIFFRACTION ON PARALLEL LIGHT

different than with transparent objects. In the latter case the illuminating system passes the light rays directly through the specimen and into the miscroscope. The resolution of the system, or the power to render visible the various parts of the object, is an important consideration, as well as the thickness and quality of specimen, glass slide and cover glass. In low power work we are able to make full use of the resolving power of the lens and it is comparatively easy to obtain

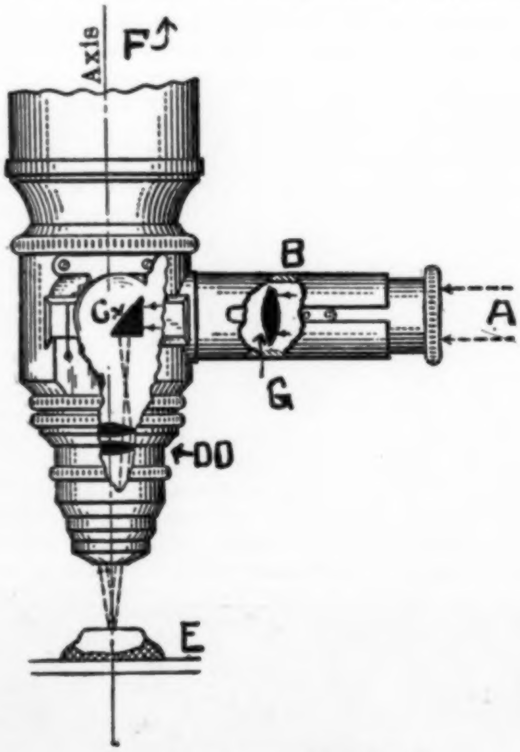


FIG. 4. PRISM ILLUMINATOR

perfect results. As we understand it, resolution may be defined as the ability of an objective to render correctly the diffraction phenomena of a subject in transmitted light. If we place a rod in a stream of water the water flows around it. If we place a rod in a beam of light some of the rays no longer travel straight but bend around the edges of the obstruction—this we call diffraction. Such opaque lines in a subject may be several thousand per inch, when the diffraction image will be confusing and if not correctly rendered will lead to misinterpretation. (Fig. 3.)

In the case of opaque objects reflected light is used, the objective acting both as condenser and objective. At first sight it appears quite impossible that the objective can transmit light in one direction to illuminate a subject and transmit in the opposite direction the image of an object so illuminated without interference. Yet in this case one is concerned mostly with

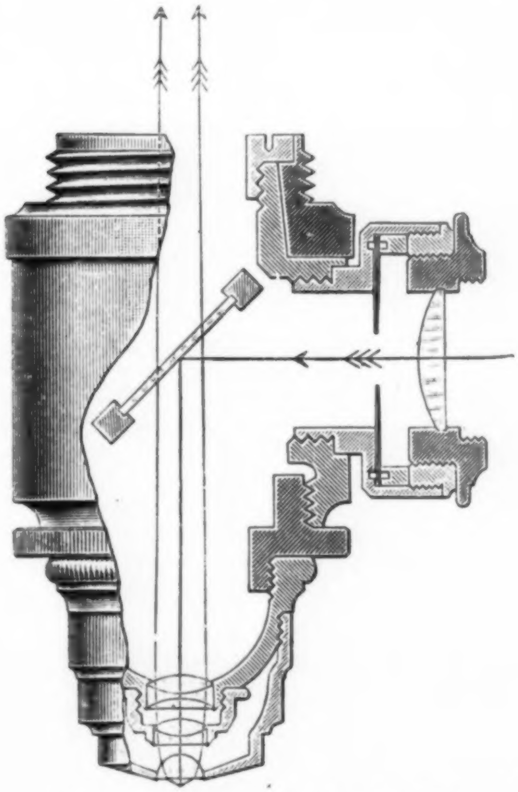
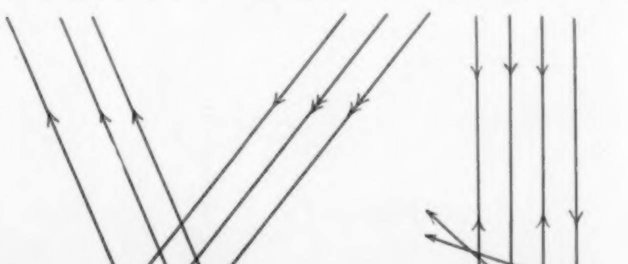


FIG. 5. PLANE GLASS REFLECTOR

the defining power of the lens, rather than its resolution.

There is another important qualification for the microscope lenses—their correction for color. The ordinary microscope has achromatic lenses, that is to say, they are corrected for two regions of the spectrum so that there is little trouble with color fringes at low powers. A superior system of lenses is called apochromatic; these bring the three regions—red, green and blue—to a perfect focus with the image by the use of lenses of different kinds of glass, so that there are



FIGS. 6 AND 7. AT LEFT—OBLIQUE LIGHT RENDERS THE SUBJECT DARK WITH FEW BRIGHT LIGHTS, ALTERING THE APPEARANCE OF THE RELIEF. AT RIGHT—VERTICAL ILLUMINATION RENDERS BLACKS AS BLACK AND POLISHED SURFACES LIGHT

no color fringes. In using the microscope for ocular observation, color fringes, defects due to spherical aberration and lack of definition are not always serious defects, because the eye is something of a compensator and has "persistence of vision." In photography, color fringes destroy the sharpness of the image, while spherical aberration, producing different foci for central and marginal rays, permits only a portion of the subject to be clearly defined on one exposure, so the results may be not only unintelligible but misleading. The plate has no imagination, it records the facts as presented.

Illumination of Opaque Objects

To illuminate an opaque object such as a piece of polished metal, a vertical illuminator furnishes the only correct rendering, but its use does impair the optical qualities of the objective. In the customary objective for transmitted light, the lenses are mounted at varying distances by different makers, and corrected

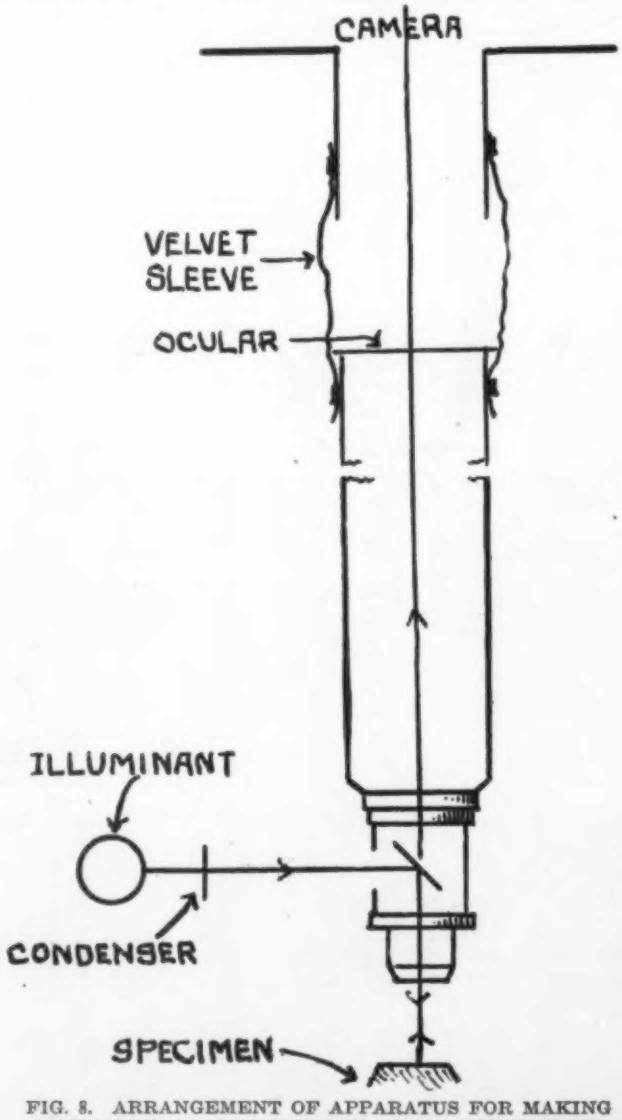


FIG. 8. ARRANGEMENT OF APPARATUS FOR MAKING MOTION PHOTO MICROGRAPHS OF OPAQUE OBJECTS

for a cover glass over the specimen. For use with the vertical illuminator the lenses must be short mounted to avoid internal reflections and uncorrected for cover glass—none being necessary.

Figs. 4 and 5 illustrate two common types of vertical

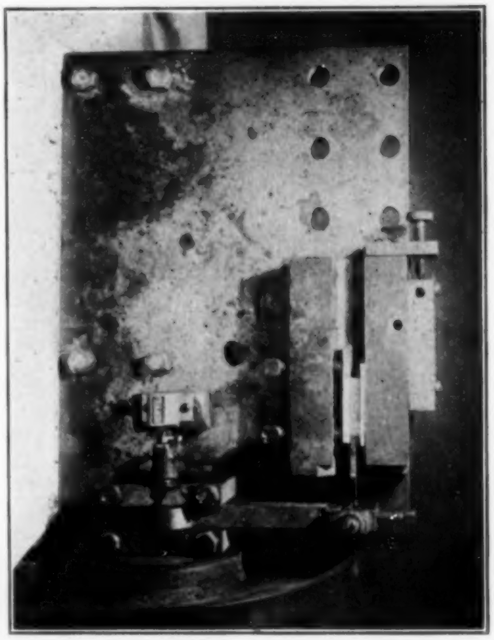


FIG. 9. STRESSING MACHINE DESIGNED BY PROF. H. F. MOORE, WITH TEST SPECIMEN IN PLACE. ROTATION OF FLYWHEEL TRANSMITS VERTICAL OSCILLATION TO THE OTHER END OF THE TEST PIECE, PRODUCING BENDING AT THE VISE

illuminators. With the plane glass reflector there is a tendency to produce a haze over the image, while with the prism there is a tendency to form a sculptured or relief image. Yet either gives satisfactory results under proper conditions.

From the illustration (Fig. 4) it is seen that the illuminant at *A* passes its light into the tube *B* (preferably in parallel rays) through the converging lens *G* which focuses the light source on the hypotenuse of the prism *C*, thence through the objective lenses *DD* which concentrate the light on the subject *E*. An image of *E* is formed by *DD* projecting it to the ocular *F* which not only magnifies the image but corrects errors of the objective.

Such illumination does not appear to be a difficult operation, yet under some conditions trying difficulties occur. For instance, it is essential that *AB* be at right angles to the microscope tube and that the lenses be clean and free from dust. (It seems quite impossible to keep dust from the lenses; it returns again and again.) The axis must be perpendicular to *E*, otherwise

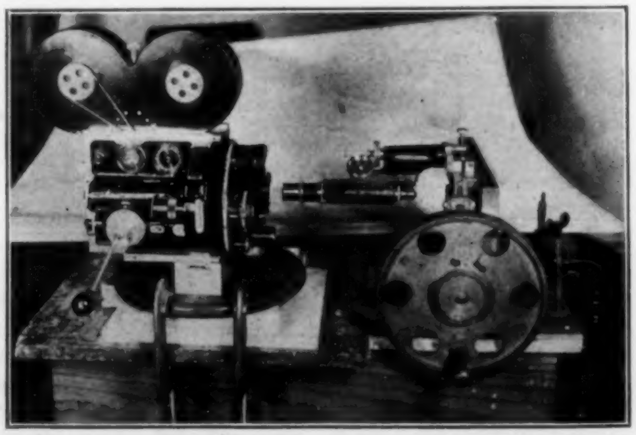


FIG. 10. ASSEMBLED APPARATUS WITHOUT VELVET SLEEVE OR ILLUMINATING DEVICE

the specimen will not appear properly illuminated. It is seen in Fig. 6 that if the light is at all oblique the reflected rays which should pass into the objective will fall outside. The relief will be changed in appearance and the object will appear but partly lighted. In Fig. 7 the light falls vertically, most of it returns to the objective and the relief appears correctly.

Illumination for Motion Picture Camera

To make motion pictures through this apparatus it is necessary to place a motion picture camera at a short distance from the ocular *F*, as shown in Fig. 8. The lenses are preferably removed, while magnification is changed by using oculars of various powers.

For motion work of this nature a flickerless light-source is necessary, as any fluctuations in illumination are recorded in the negative. The axes of light-source and of microscope must be at right angles horizontally and vertically, and the surface of the film must be at right angles to the axis of the microscope. Furthermore, all of the elements must be rigidly fixed. To comply with these conditions in a built-up apparatus requires considerable time and care. As a case at hand, some motion pictures of a wrought-iron test bar showing the mechanism of failure under alternating stresses were made for Prof. H. F. Moore of the Materials Testing Laboratory, University of Illinois, the designer of the fatigue machine (Fig. 9). I used a 400-watt gas-filled lamp of stereopticon type, the image of one filament only being employed, which was projected into the tube by the condensers of a No. 0 delineascope. An arc was found to be not only too intense but too variable in color and position. A gas-filled bulb with only one filament would be very desirable, while the Nernst or the new incandescent lamp as used for motion picture projection might answer well. It is best to absorb the heat from the light with a water cell. A prism illuminator was used with an achromatic objective and a compensating ocular, as these oculars give much better results than a Huyghenian.

Motion Microphotographs

All types of motion cameras are not readily adaptable to these special problems. Devices have been constructed for making motion pictures in various lines of research, notably at the Marey Institute in France. For my purpose I found the Bell and Howell camera an incomparable instrument. It is entirely of metal, compact and mechanically faultless. The rotating lens turret and the sliding base permit the focusing aperture to be moved to the exact position occupied by the film when recording.

As shown in Fig. 10, the camera and the stressing machine are clamped very firmly to a substantial table—a masonry pier would be more desirable—and the camera is then connected to the microscope by a black velvet sleeve to facilitate adjustments and to break the transmission of any vibration. A device for observing the action continuously by eye might be inserted but would result in some loss of definition. The microscope

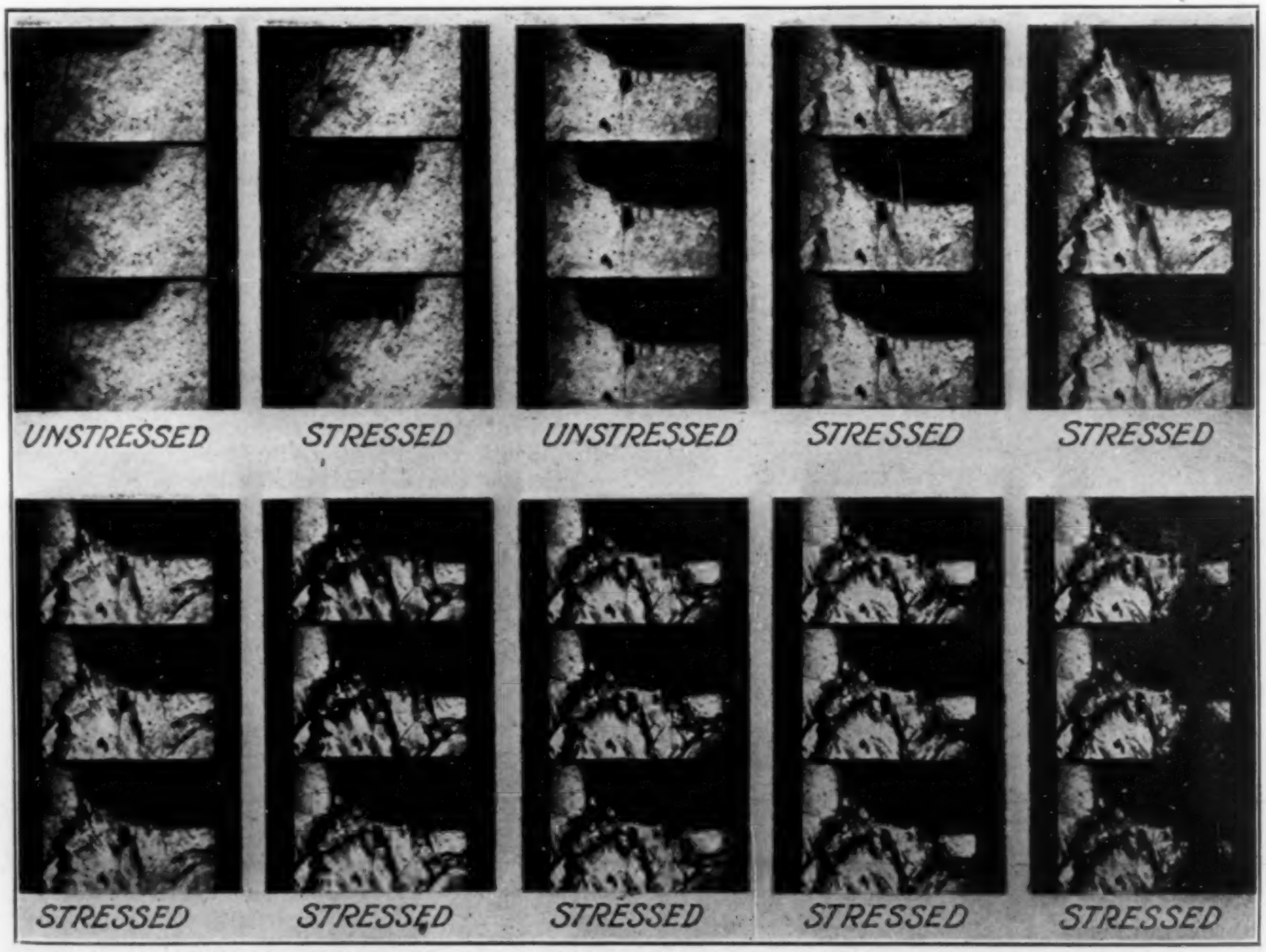


FIG. 11. MOTION PICTURES THROUGH THE MICROSCOPE. SUCCESSIVE STAGES IN REPEATED STRESS OF WROUGHT IRON. × 70

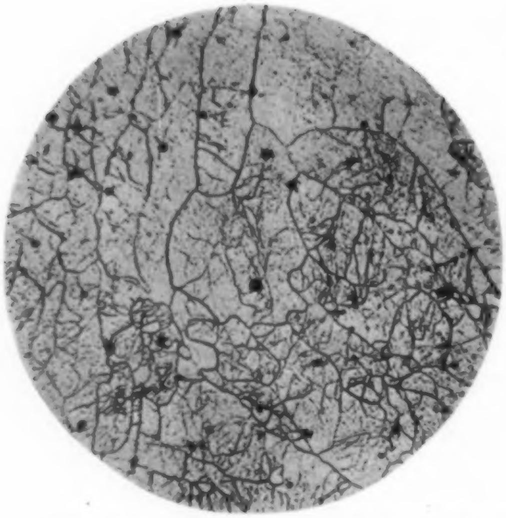


FIG. 12. STRUCTURE OF WROUGHT IRON BEFORE BEING SUBJECTED TO REPEATED BENDING STRESSES. × 200

was first focused on a polished region at the base of the shoulder, shown in Fig. 9, where the stresses will be most intense.

Photographs of metals are usually at low power—one hundred or less. In making motion pictures the magnification was even lower in order to exhibit a sufficient field for study. This leads to more difficulty, because in the low magnification, the lines made by the crystal boundaries become so narrow that it is difficult to retain them in negative and positive with enough density to project well. It is possible to improve the sharpness of the image by using deep colored screens, preferably in the blue-green, thus eliminating other colors which might form color fringes. If this is done, panchromatic film is necessary. By the accompanying table of resolving powers for transmitted light it is seen how much the working qualities of lenses are improved by increasing the numerical aperture and decreasing the wave length. Violet light is difficult to use, however, because the eye works very poorly in that region and it is quite impossible to focus the object, even with a magnifier. Sections of the film made in the present instance are shown in Fig. 11, while exposures of the same test made at higher powers with an

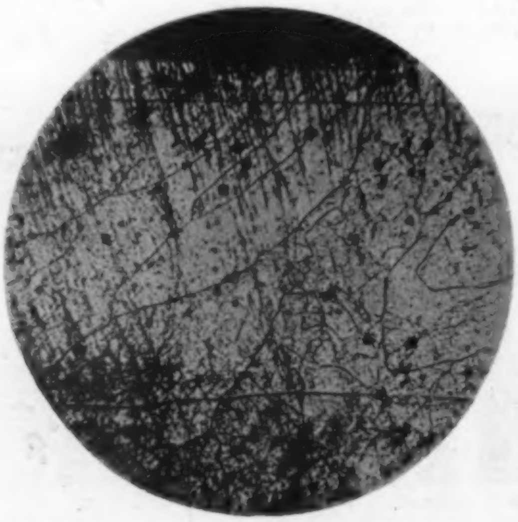


FIG. 13. SLIP LINES DEVELOPING ACROSS THE CRYSTALS. × 200

ordinary metallographic microscope are shown for comparison in Figs. 12, 13 and 14. In the results shown here the negative was made on positive film at the

LIMITING RESOLUTION

Objective	N.A.	Yellow line D $\lambda = 5896$ A.U.	Green line E $\lambda = 5269$ A.U.	Violet line Hγ $\lambda = 4341$ A.U.
1½	.10	8,617	9,641	11,699
⅔	.25	21,542	24,103	29,247
¼	.6	51,700	57,846	70,193
⅙	.9	77,550	86,769	105,289
Oil immersion $\frac{1}{12}$	1.4	120,638	134,974	163,783

normal speed of 16 pictures per second, giving an exposure of $\frac{1}{48}$ of a second, the negative film being too fast and not giving satisfactory contrast.

The little work which I have done in this field and the consideration of other special problems lead me to think that the motion camera with and without the microscope offers a means of research the value of which we can hardly predict. The field of application is as wide as human knowledge. Processes and reactions in the natural sciences and phenomena in the physical sciences will unfold many opportunities as we search for new facts. Special apparatus has been constructed

FIG. 14. WROUGHT IRON AFTER REPEATED BENDING STRESS. × 200. THE FINE LINES ARE "SLIP LINES" DEVELOPING ACROSS THE CRYSTALS

whereby consecutive exposures can be made, each in one ten-millionth of a second. With such a tool, the transmission and reaction of sound waves might be quite readily photographed in motion.

One day some one may record the passage of electrons discharged across a vacuum. We can hardly set a limit.

University of Illinois.
Urbana, Ill.

Where Hamlet Was

Referring to our notes under the title of "'Hamlet' with Hamlet Left Out," in our last issue, Major Charles E. Sholes, honorary chairman of the N. Y. Section of the Society of Chemical Industry, calls attention to the fact that it was not the fault of the authors that the paper on Fuels was missing. The manuscript had been mailed in ample time and was *en route*, where it rested for a considerable period along with the information that the authors, Messrs. Bacon and Hamor, were prevented by pressure of other duties from putting in personal appearance. It will appear in an early number of the Journal of the Society.

An Improved Method of Optical Glass Manufacture*

By George W. Morey

THE USUAL practice in the manufacture of optical glass consists of the following sequence of furnace operations:

The pot is carefully preheated in a small subsidiary furnace, called a pot arch; from there it is "set," or transferred to the furnace. The pot is usually set at a temperature of about 1050 deg. C., and it must be heated up to the melting temperature of the glass batch, about 1400 deg. for most glasses, before filling. The best practice is to overburn the pot before commencing the fill.

The batch, or batch mixed with cullet, is fed into the pot in several installments, until the fill is complete. The details of this process differ from plant to plant.

After the fill is complete, the glass is left undisturbed for several hours, primarily to give time for the bubbles to rise to the surface. The temperature during this period is high; in some places it is the practice to use a higher temperature for the fining operation than for the fill.

After the fining period is complete, it is customary to stir the glass by hand, intermittently; a common schedule is to hand stir for 15 minutes every two hours. This process removes the bubbles of gas adhering to the side and bottom of the pot, and helps to secure uniformity in composition.

After the period of intermittent hand stirring is complete, the glass is stirred continuously, a stirring machine being used. As a rule, soon after putting on the machine, the fire is turned off and the glass allowed to cool, stirring being continued until the pot is removed from the furnace. The operations summarized above take from two to three days in the furnace, the actual time depending on local practice. When, as is usually the case, the empty pots are preheated in pot arches, and the finish glass cooled in an appropriate subsidiary apparatus, a melting furnace will yield one pot of glass every two days.

New Schedule Doubled Production

After considerable experience in manufacturing optical glass, certain of the usual operations seemed to be inadequate or illogical, and soon after taking charge of the optical glass plant of the Spencer Lens Co. for the War Industries Board, I devised a new schedule radically different from the above, which may be called the "24-hour" process. Because of its importance in practically doubling the production of optical glass, a basic material in the manufacture of fire control instruments, the details of the process were communicated to the Military Optical Glass and Instrument Section of the War Industries Board, and were communicated by them to the other manufacturers of optical glass.

In the first place, the filling operation required modification. Melting of the batch takes place from the top downward; the upper layer sinters together, then the more easily fusible components trickle down, leaving the upper layers impoverished in the substances usually called "fluxes." This results in the surface becoming high in silica; this is proved by skimmings from both crown and flint batches, which not only showed an actual accumulation of partially dissolved quartz grains, but also had a refractive index lower than that of the rest of the glass.

Harmful Effects of Fluxes Settling to the Bottom Overlooked

The fluxes, especially lead, tend to settle to the bottom; this is proved by the dark layer always brought up when hand stirring is begun, by tests made by plunging a long iron rod into the glass and quickly withdrawing it, and by the examination of partially melted pots which have been removed from the furnace because of leaks, and broken after cooling. In the latter case, the preponderance of silica mentioned above has also been observed.

This initial inhomogeneity, it is true, is removed by the subsequent stirring operation, and this probably accounts for its harmful effects having been overlooked. One of these harmful effects, especially in flint glasses, is due to the fact that lead-rich mixtures (for example the extra-dense flints) are extremely corrosive on the pots. By the older process this lead-rich layer is allowed to lie on the bottom of the pot throughout the filling and the fining periods, both of which periods are of some hours' duration and of extremely high temperatures. This necessarily results in greatly increased pot corrosion. In addition, the impoverishment of the upper layers in fluxes increases the time required for complete solution of the batch ingredients.

Stirring During Fill the Remedy

The obvious remedy is to stir during the fill.[1] This is not feasible until the pot is a little over half full, because the stirring rod cannot be floated before this, but as soon as feasible it should be begun, and the melt should be stirred each time new batch is added. Making such a stir during the fill should diminish pot corrosion, give glass of a better quality, freer from color, striæ and stones, and should hasten the solution of the batch and thereby shorten the melting process.

After the fill is completed, the glass must be freed from bubbles of gas arising from the decomposition of carbonates and nitrates in the batch, and from the water in the batch ingredients. In some cases these volatile components comprise one-fifth of the weight of batch filled. By the old process the bubbles are mainly removed during the fining operation, the glass being kept hot and undisturbed for some time to allow the bubbles to rise to the surface. The intermittent hand stir following supplements the fining period by removing the layer of bubbles which adheres to the pot walls, and also tends to secure uniformity in composition throughout the melt.

Stirring the Logical Way to Remove Bubbles

That seemed an illogical way to secure the desired result. In the first place, common experience is that bubbles in other liquids are more rapidly removed by stirring than by quiescence. It seemed reasonable to suppose that in a pot of glass also the bubbles will be more rapidly removed by stirring. Moreover, in the usual process the glass is not homogeneous in composition until after the fining period; the upper layer is deficient in fluxes, and hence melts less rapidly than the mass of the glass. The margin in composition be-

*Read before the American Ceramic Society at Pittsburgh, Feb. 3-6, 1919.

[1]Since presenting this paper I have heard that at one time stirring during the fill was tried at the Charleroi plant of the Pittsburgh Plate Glass Co.; others doubtless have made the same attempt.

tween an unworkably viscous glass and a workable glass is a narrow one; the stirring should prevent the upper portion being deficient in fluxes and hence too viscous to permit the free passage of bubbles. It seemed a reasonable supposition, therefore, that two of the operations to which optical glass is usually subjected could be dispensed with, namely, the long fining period and the period of intermittent hand stirring. In other words, it seemed that better results could be obtained by putting on the stirring machine immediately after the fill, and stirring continuously until the glass was free from bubbles. With this modification could well be combined a hand stir during the fill, as mentioned before.

Results Prove Reasoning Good

The best test of this reasoning is the results. The new schedule was tried out on a melt of flint glass having an index of 1.617. The melt was run at the usual temperature for this glass, 1390 deg. C. Fills were made at 2-hr. intervals, the first fill being about one-third of the total batch, and on each subsequent fill the pot was heaped up with batch. As soon as possible a hand stir was made; ten hours after the first fill the stirring machine was put on; at this time there was still undissolved batch, not all quartz. The stirring machine was run at a good speed, both with a circular and with a vertical motion. After six hours the glass seemed free from bubbles; the fire was accordingly turned off and the pot cooled and removed as usual. The entire process, from the time the pot was set until the melt was out of the furnace and another pot set, was 24 hours. When the glass was examined, it proved to be of the best quality, wholly free from bubbles, of greatly improved color, and also freer from striæ than usual.

Special Schedules for Different Types of Glass

The details of the process were subsequently modified, and special schedules were worked out for the different types of glass. Following is a sample schedule, being that for a flint having $N_d = 1.617$, $\nu = 36.5$. The pot used is 26 in. high and 28 in. in diameter, inside dimensions. The time of filling in the cullet is taken as zero hour.

SCHEDULE FOR MF_2 GLASS
Run at 1390 Deg. C.

Hr.	
0:00	Add cullet
1:00	Fill pot three-quarter full of batch
2:30	Fill pot with batch
4:00	Hand stir; fill pot with batch
5:30	Hand stir; fill pot with batch
7:00	Hand stir; fill pot with batch
7:30	Stirring machine on
15:00	Gas off

When cooled to the proper temperature the pot of glass is removed from the furnace, and slowly cooled in a pot arch. A new pot is set into the furnace, and given a preliminary burning, so that in 24 hours all is ready for another melt.

It may be well to emphasize one point of difference between the longer process and the 24-hr. process. In the former the melt, often with an unduly corrosive layer on the bottom, remained in contact with the hot pot for from 20 to 30 hours from the time the last fill was made until the gás was turned off; in the 24-hr. process the corresponding period of maximum corrosive action is 5 or 6 hours. As the majority of the contamination of glass, with our present raw materials, comes from the pot, the superiority of the newer process is obvious. Better color results from smaller pot contamination, as well as a greater freedom from striæ, less trouble from stones and less pot breakage.

Process Proving a Success

The first experimental pot of glass made by the 24-hr. process proved a complete success. Since that time some 350 pots of glass have been made by the shorter schedule. They comprise practically all types of glass; flints, from an extra-dense flint with refractive index of 1.76 to an extra light flint with index of 1.55; soft crowns and ordinary crowns of three different types; several types of borosilicate crown; several barium crowns, both light and dense, and several baryta flints, ranging from a light baryta flint with index 1.56 to a dense baryta flint, index 1.62. Without exception the new process has produced a better glass than the old, with a doubling of production and correspondingly lower cost.

Spencer Lens Glass Plant, Hamburg, N. Y.
Geophysical Laboratory, Washington, D. C.

Some Wild Engineering I Have Known*

By David Wesson

Many, if not most, of the troubles in this world come from lack of knowledge of the natural laws and their proper application to practical problems. The theories of practical men are often examples of the old saying that a little knowledge is a dangerous thing. It sometimes leads to wild conclusions, as in the case of the Irish foreman who was seen thoughtfully studying a light footbridge between two buildings about 60 feet apart. Resting on the bridge was a three inch steam pipe. On being asked what the matter was, the foreman said, "That pipe carries 80 pounds of steam to the inch and 960 pounds to the foot, and the bridge is 60 feet long, which figures to 57,600 pounds, and I'm after thinking that must be an awful strong bridge."

The above incident happened before the days of chemical engineering and the chemist who worked out from his laboratory into the plant had to depend on the plant engineer to put his ideas into practice. In those days the plant engineer was more likely than not a man who had graduated from the machine shop and engine room, with a very hazy idea of physics but a strong reliance on his practical experience and ability to guess. When such a man and a chemist started to design a plant it was often a case of the blind leading the blind, and things were created which sometimes worked and sometimes did not. Difficulties arising from such causes naturally set the scientific minds of the chemists to looking into the causes, and after a proper diagnosis it was comparatively easy for the chemist to design what was needed and let the mechanic do the actual construction work. This, in the writer's opinion, was the genesis of the chemical engineer.

The writer had the privilege in 1887 of visiting most of the pioneer cotton oil refineries of the country. They were built by mechanics, not chemists, and varied greatly in design and construction. One plant was equipped with cylindrical tanks with flat bottoms and agitated with paddles revolving on a horizontal axis passing

*Extract from a paper read at the Chicago meeting of the American Institute of Chemical Engineers on Jan. 17, 1919.

through the walls of the tank. The soap stock formed in the process of refining was drawn off as much as possible from the flat bottom after each refining, and what was left went into the next batch.

Weird Refinery Practices

Another refinery showed with pride a large tank made to refine 400 barrels at one batch, but they never worked it more than half full because the heating coil was too small to heat the oil rapidly enough, though sufficiently large to condense all the steam from the entire boiler plant.

A refinery in New England noted for the fine quality of its oil did all its work with 1½-in. pipe lines and kept small pumps going 24 hours per day to handle comparatively small quantities of oil.

About 1888 or 1889 a new company put up five large oil mills which were equipped with Abendroth Root high pressure water-tube boilers and Brotherhood engines sprinkled about the large barnlike mills. Pipe covering and insulation were considered useless luxuries, and naturally the mills did not operate very successfully. The engines were natural steam hogs, and the overworked boilers were always breaking down. The management had to change the type of boilers and install central power plants with Corliss engines before their mills were put on a paying basis.

Funny Things Seen in Pipe Lines

In running pipe lines funny things happen sometimes. I remember seeing in a certain plant in Germany a pipe bent on a beautiful curve on a 3-ft. radius and connected into the sharpest kind of a right angled elbow at one end of the bend.

In a plant at Memphis some years ago a filter press was located in the top of a refinery, and the 4-in. pipe line to carry off the filtered oil to storage tanks 100 ft. distant was run by the engineer in charge with a 4-ft. drop straight to the storage tanks. When the filter pump was started up the pipe line was found too small to carry off the oil and the pan overflowed. Of course the plant was practically tied up till a chemist arrived on the scene and ordered the pipe line dropped to a horizontal position and connected with a 3-ft. vertical pipe from the filter trough. In the first case a straight line, though the shortest distance between two points, did not have more than a 6 in. of head to force the oil through it, while in the second case there was a little over 3 ft. of head and the oil ran off freely.

Engineers who should know better design large tanks to be heated by steam jackets instead of suitable coils. They do not realize that it is impossible to get sufficient heating surface in jackets, nor do they consider the danger in working with jackets at high pressure.

To Prevent Fires—Don't Erect Buildings

In a Southern city some years ago there was a plant engaged in distilling rosin to make rosin oils. Fires were frequent, and the cheap frame buildings over the stills were burned down. Finally the brilliant plan was evolved of doing the work out of doors. After that they had no more conflagrations but in cold and rainy weather the stills did not work very well. Some neighboring manufacturers engaged in distilling fatty acids tried the same scheme. The stills were out of doors, the condensers were in a fireproof house. There were no fire damages to be paid for by the insurance companies, but the quantities of fuel used in cold and wet weather, the smaller amount of fat converted into tar, the lost time and repairs soon amounted to several times more than a house over the stills, which was eventually built during the absence of the general manager, with the result that the plant became more profitable shortly afterward.

A mistake frequently observed is the design of tanks to be used under vacuum with too light materials, with the result that they collapse when put in use.

All of us looking back over our experiences can think of many other examples of wild engineering leading to more or less disastrous results. The foregoing cases are sufficient to illustrate the ease with which people who should know better are apt to transgress physical laws, which are capable of demonstration. The results, while bad enough, are infinitesimal as compared with those obtained by some of our elected statesmen, who often from ignorance and often for the sake of votes take great liberty with social and economic laws and commit social and economical engineering atrocities. The law of supply and demand, for example, is as immutable as the law of gravitation, but how often have we seen it defied by Government officials. We can hold back the flood of a watercourse for a time by constructing a suitable dam, but sooner or later if the water supplies keep increasing the dam will either overflow or be carried away and destruction will result.

Wild "Engineering" by Legislators

The prices of labor and materials of all sorts can be maintained at unnatural levels by war-time restrictions, as we have all seen, but the moment war-time conditions remove the prop from the dam, unless suitable channels are constructed to reduce gradually and safely the pent-up level of the flood, disaster is bound to ensue.

When one sees legislators passing laws preventing the formation of large industrial and transportation aggregates, it would seem that a lesson might be taken from the courtiers of King Canute, who imagined that a word from the governing powers would prevent the rising of the tide when they placed the King on his throne upon the beach.

Co-operation Needed

The lesson we must all learn from the war and the period preceding it is that the day of co-operation is at hand. By the co-operation of nations the common enemy was defeated. By the co-operation of railroads and steamship lines in our own country transportation was speeded up. By the co-operation of industries production was increased enormously. Now that the war is over the need of co-operation is greater than ever. The so-called conflicting interests of labor and capital must be caused to co-operate in such a manner that our complex social fabric shall have all parts working in harmonious unison to make the most of our natural resources and create again the enormous wealth destroyed by the war. This is the problem we all have before us and to which we will have to devote our best energies, both as worthy citizens of our great country and as members of our profession of chemical engineers.

A Proposed Metallurgical Process for the Treatment of Vanadinite for the Recovery of Lead and Vanadium*

Vanadinite Concentrate Is Fluxed and Reduced With Soda Ash, Caustic and Carbon, Giving Metallic Lead—Slag Is Elutriated, Si and Mo Precipitated With Lime—Vanadium Pentoxide 86 Per Cent Yield With Sulphuric Acid

BY J. E. CONLEY

THE supply of practically all of the vanadium used at the present time in the United States comes either from the patronite of Peru, largely controlled by the American Vanadium Co. of Pittsburgh, or from the roscoelite found near Newmire, Colo., controlled by the Primos Chemical Co. Considerable vanadium is also produced from the carnotite ores of Utah and Colorado, as a by-product in the production of radium. Practically no vanadium is obtained from other vanadium ores.

Attention has been called repeatedly to the vanadinite deposits found in the United States, particularly those of Arizona and New Mexico, but thus far very little progress has been made in developing these deposits as a source of vanadium. Some time in 1910, the Vanadium Mines Co., having acquired some vanadinite deposits in Sierra County, New Mexico, erected a mill near the mine, and a reduction plant near Cutter for the commercial treatment of the ore. A little later, however, the plant was dismantled and the mines abandoned. As far as known, this is practically the only attempt ever made in this country for the industrial treatment of vanadinite.

During the last two years a 50-ton mill has been built at Kelvin, Ariz., by the U. S. Vanadium Development Co., which planned to use the Bryan process of concentration[1]. Recently, however, this property has been leased by the Allied Metals Corporation of Denver.

Plenty of evidence is available to show that vanadinite ores have been rather extensively mined and treated at Santa Marta, Spain.

In addition to these occurrences, vanadinite is known to be found in commercial quantities in Nevada, California, and several places in Mexico, as well as in Argentina.

The concentration of vanadinite is not a difficult process unless found with other very heavy minerals. The recovery of the vanadium is quite satisfactory, providing an appreciable amount does not occur as the pentoxide. Very frequently vanadium minerals show a portion of the vanadium either as the oxide, or as compounds with calcium, copper, etc., and occur in the form of a fine powder. In these cases the recovery in concentration is considerably lowered by the tendency of the powder toward sliming. The present paper, however, is not so much concerned with the concentration of vanadinite as in the treatment of vanadinite after concentration. This phase of the work was deemed sufficiently important to undertake the investigation of the metallurgy of vanadinite for the purpose of selecting and recommending a procedure.

The ore used in these experiments was in the form of concentrates obtained from Mr. E. Payne Palmer of Phoenix, Ariz., and came originally from the property near Ray Junction, Ariz., now leased by the Allied Metals Corporation. An examination of this concentrate showed it to consist largely of vanadinite and quartz, with small amounts of iron silicates, galena, calcite and wulfenite. About 90 per cent of the ore would readily pass a 30-mesh sieve. An analysis of the samples used showed:

ANALYSIS OF CONCENTRATES

	Per Cent		Per Cent
PbO	53.88	CaO	2.10
V_2O_5	12.60	Insoluble	16.93
MoO_3	1.98	Loss on ignition	2.52
Fe_2O_3	4.26	Undetermined	4.52
Al_2O_3	1.21		

From these figures it is seen that the ore is of high grade and that the recovery of the lead is an important consideration.

PRELIMINARY METHODS TRIED FOR THE E TRACTION OF THE VALUES

Several methods of procedure were used on these concentrates, either by trying to apply treatments already being successfully used on other vanadium minerals, or by any methods which presented possibilities. The earlier experiments were made for the purpose of extracting the vanadium, but it is seen that the treatment should be materially influenced by the lead present. Any method not adapted to the recovery of this lead must certainly be unsatisfactory.

An outline of the methods tried which were found unsatisfactory is given in Table I.

TABLE I—METHODS TRIED ON VANADINITE CONCENTRATES

Treatment	Reagents Used	Results
1. Alkaline leach	Strong solutions of caustic and sodium carbonate	Less than 1 per cent of vanadium soluble
2. Acid leach	Dilute and concentrated sulphuric acid	Poor extractions
3. Acid leach	Dilute and concentrated hydrochloric acid	Poor extractions with permissible quantity of acid
4. Fusion	Niter cake; niter cake and charcoal	45 per cent extracted with niter cake; increased to 85 per cent by addition of charcoal
5. Fusion	Soda ash and sodium nitrate	Very fluid slags, but poor extractions

None of the methods given in Table I was found to give sufficiently satisfactory recoveries to be recommended as a process for treating the concentrates. As can be seen, none of the methods is adapted to a direct recovery of the lead.

FUSION WITH SODA ASH AND CAUSTIC SODA

Innumerable fusions were made with the concentrates by using soda ash, caustic soda, and mixtures of both, with the addition of charcoal. A mixture of soda

*Published by permission of the Director of the Bureau of Mines.
[1]*Eng. & Min. Jour.*, Vol. 107, No. 3, p. 149.

ash and caustic soda was eventually found that could be recommended as quite satisfactory for good recoveries at reasonable costs. The results of these fusions will be given together with the amounts of flux required.

Fusion Experiments With Caustic Soda and Soda Ash

The fusion of vanadinite with these fluxes, using charcoal as a reducing agent, favors in a measure the extraction of the lead. The lead requires a reducing fusion, while the vanadium is best extracted in an oxidizing fusion. It is the highest oxide of vanadium, the pentoxide, which possesses acidic properties and which is used in reacting with the bases to form soluble sodium vanadate. Conditions of the fusion, therefore, are favorable for the formation of the lower oxides which possess basic properties. This condition is overcome, however, by heating the slag to obtain oxidation, or by the addition of a small amount of a suitable oxidizing agent, such as niter, after the removal of the lead. Higher extractions are always secured if these precautions are taken.

Reference to Table II will show the results obtained by varying the proportions and amounts of flux used.

TABLE II.

No. of Run	Ore Used (Grams)	Na_2CO_3 (Grams)	NaOH (Grams)	Charcoal (Grams)	Per Cent V_2O_5	Extraction. Pb
1	5.0	5.0	2.0	0.2	97.8	....
2	5.0	4.0	2.0	0.2	96.0	....
3	5.0	4.0	1.0	0.2	95.6	....
4	5.0	3.0	3.0	0.2	96.2	....
5	50.0	25.0	10.0	0.5	76.0	80.0
6	50.0	20.0	5.0	2.0	74.0	80.0
7	50.0	10.0	25.0	1.25	94.6	95.8
8	50.0	10.0	20.0	1.25	95.4	91.9
9	50.0	5.0	20.0	1.25	96.1	94.7
10	50.0	0.0	20.0	1.25	94.0	95.0
11	50.0	5.0	15.0	1.25	91.3	91.1
12	50.0	0.0	15.0	1.25	9.0	92.7

In these fusions, caustic soda was found far more efficient than soda ash in rendering the vanadium water-soluble. Soda ash has been actually used, both at Cutter, N. M., and more successfully upon the vanadinite ores at Santa Marta, Spain. These ores, containing from 12 to 14 per cent vanadium pentoxide and about 50 per cent lead, very nearly correspond to the concentrates used in these experiments. It was found, however, that in any fusion in which the amount of caustic was less than 20 per cent of the weight of the ore, the vanadium extraction dropped rapidly, an objection which was but partly overcome by increasing the amount of soda ash. By reference to the table, it is seen that a sample fused with 30 per cent of its weight of caustic yielded only 9 per cent of its vanadium, but when the caustic was raised to 40 per cent, the extraction was 94 per cent.

In all the experiments made, the caustic soda, although higher priced, was far more satisfactory, both for recovery of lead and vanadium. Caustic soda was expected to give a poorer lead recovery than the soda ash, but it was actually found to give better. This can probably be explained by the fact that a more fluid slag is obtained, which facilitates the settling of the lead.

The prediction that the proportions of flux recommended will work out satisfactorily on a large scale is borne out by a run made on a 50-lb. sample. Fifty lb. of ore fused with 20 lb. of caustic, 5 lb. of soda ash and 2 lb. of coal yielded 23½ lb. of lead and gave a vanadium extraction of 89.6 per cent.

The actual literature on the treatment of vanadium ores is very meager and incomplete. Most of the information on the treatment of the ores is kept secret, and the small amount made public is carefully covered by patents. This is true of vanadium more than any other of the rare metals.

In the small amount of literature really available on the treatment of the vanadium ores, special emphasis is given to the treatment of the ores. Practically no emphasis is laid upon the recovery of the vanadium from the solutions obtained. This part of the subject is usually dismissed with some such statement as, "The vanadium may be recovered from solution by any of the well-known methods."

The recovery of the vanadium from solution as a high-grade product by an efficient and economical method is by no means the less important part of the process.

In these experiments for the recovery of the vanadium from solution, three procedures were used.

1. The direct precipitation of the vanadium from the alkaline solution obtained by leaching the slag after removal of the lead. The precipitants used were:
   (a) Calcium chloride.
   (b) Chloride of lime and slaked lime.
   (c) Slaked lime.
   (d) Calcium sulphate.
   (e) Barium hydroxide and chloride.
2. Evaporation of solution to dryness in the presence of an excess of acid. The acids used were:
   (a) Sulphuric.
   (b) Nitric.
   (c) Hydrochloric.
3. The precipitation of the vanadium as the pentoxide by boiling in sulphuric acid solution.

Experiments on the Precipitation of Vanadium From Alkaline Solution

In these experiments preference was shown the common calcium salts. This was due to the cheapness of the reagents, as well as to the properties of the resulting product, namely, calcium vanadate. Many of the vanadates show a more or less tendency to form colloidal precipitates which filter very poorly. This tendency is less marked with calcium vanadate, so that a product which filters readily and permits washing is usually obtained.

The precipitation of the vanadium as iron vanadate necessitates the neutralization of the solution, as iron vanadate is best precipitated in a slightly acid solution. This was confirmed by some experiments made on the recovery of vanadium from a sulphuric acid solution obtained in treating cuprodescloizite. This precipitation, however, is being satisfactorily used at the present time and could, no doubt, be applied to this ore. This treatment is not so well adapted to the procedure adopted and to be later recommended.

Complete precipitation of the vanadium was obtained by using an excess of calcium chloride, barium chloride and calcium sulphate. With all three of these precipitants, all of the vanadium is not removed until the solution is made neutral. The principal objection to these reagents is that a large portion of the molybdenum is also precipitated simultaneously, since calcium molybdate is precipitated in a neutral solution. Complete precipitation was not obtained with a large excess of chloride of lime.

Both slaked lime and barium hydroxide precipitated the vanadium readily. Since both of these reagents increased instead of decreased the alkalinity, the result-

ing products were practically free from molybdenum. This is an important point in connection with results obtained later, since more or less wulfenite always occurs with vanadinite ores. Calcium sulphate precipitates some of the molybdenum, but only a small portion of that precipitated by either calcium or barium chlorides.

The highest grade of calcium vanadate that could be consistently maintained, and at the same time secure a satisfactory recovery, was about 16 per cent vanadium pentoxide. The grade of barium vanadate obtained from the same solution was a little better, some of the samples running as high at 21.5 per cent vanadium pentoxide. The use of barium chloride as a precipitant was not considered desirable in a commercial process.

Precipitation by Slaked Lime

The procedure followed in the precipitation of the vanadium by the slaked lime was as follows:

The alkaline solution containing the vanadium was heated almost to boiling and a thick emulsion of lime added. The mixture was then boiled and stirred frequently. This procedure was continued with the addition of more lime from time to time until the liquor showed that all of the vanadium had been precipitated. The alkalinity of the liquor is found to be increased by this treatment—a fact which assists in keeping the molybdenum in solution.

No special alkalinity was necessary or desirable for the precipitation of the vanadium, as some of the liquors after precipitation of the vanadium varied in alkalinity from an equivalent of 27.4 to 73.4 g. of sodium hydroxide per liter.

An approximate idea of the amount of lime required to precipitate the vanadium is best obtained by adding lime with the object of making a 16 per cent product, taking into consideration the fact that a portion of the silica and all of the carbonate present are also precipitated. All attempts to use less than this amount and to secure a better product by increasing the time of boiling, failed. In most of these cases, the resulting product was found to run from 15 to 17 per cent V_2O_5, and only a partial recovery was effected.

A run was made to determine the feasibility of using the 16 per cent calcium vanadate directly in the electric furnace for the preparation of ferrovanadium.

A ferrovanadium containing 38 per cent metallic vanadium was obtained. The loss of vanadium in the slag was extremely low, so that a good recovery was secured. The impurities in the ferrovanadium were all below the permissible amounts, with the exception of carbon, which can be controlled by more careful manipulation. Taken as a whole, the experiment was quite satisfactory in that both a high-grade alloy and a good recovery of vanadium were obtained.

The run would indicate that the product could be used without further treatment for the production of the ferrovanadium.

Attempts to Improve Grade of Calcium Vanadate

To be commercially satisfactory, the vanadium pentoxide content of calcium vanadate must be from 25 to 30 per cent. An attempt was made to raise the grade of the first product up to these figures by igniting the first product and using again for precipitating a new lot of alkaline solution. The ignition itself, which decomposed the hydrate and carbonate, raised the percentage from 16 to 18. The grade of the product obtained by using the first calcium vanadate instead of lime yielded a 25 per cent calcium vanadate, which was raised to 26 per cent on ignition. Thus it is seen that a product just on the lower limit of the commercial product was secured. A third precipitation, by using the second product, only raised the grade by an additional 1 per cent. This scheme can be applied for obtaining a commercially satisfactory product at what would seem a very reasonable cost. Two precipitations seem to be all that could be advantageously used.

Neutralizing Alkaline Solution With Excess of Acid and Evaporating to Dryness

An attempt was made to obtain the vanadium as the oxide by adding only sufficient acid to insure a slight excess and then evaporating to dryness. The soluble salts were leached out with water, leaving behind the crude V_2O_5. The common mineral acids, nitric, hydrochloric and sulphuric, were used.

The chief difficulty in this scheme was to obtain a good recovery with the small amounts of acid commercially possible. Another objection is the interference of the silica, which is simultaneously rendered insoluble. A larger portion of the molybdenum is also obtained, which is objectionable if the vanadium is to be used for steel.

The most promising results obtained by this method were secured by neutralizing with sulphuric and adding nitric acid for the excess. By this procedure a 92 per cent recovery of the vanadium in solution was obtained. The resulting product showed 66.8 per cent V_2O_5. The amount of nitric acid used, however, was too great to be satisfactory. The expense involved in evaporating the solution to dryness, the amount of acid required, and the contamination of the resulting product with molybdic oxide and silica are the principal objections to this procedure.

Precipitation of Vanadium Pentoxide by Boiling in Acid Solution

This method of recovering the vanadium from solution was considered the most feasible, so that considerable time and care were used in working out the conditions best suited for a good recovery of a high-grade product.

In the early experiments, it was hoped that by simply taking the alkaline solution and adding sufficient acid to make the desired concentration, the vanadium would be readily precipitated by boiling. In the attempt to carry this out, serious difficulties were encountered. Some trouble was encountered from the tendency of the silica to separate out during the neutralization. The difficulty, however, was easily overcome by diluting the alkaline solution to such an extent that after neutralization with acid the concentration would be about 10 g. per liter. It was considered that this concentration could be easily maintained on a large scale. The possibility of treating the alkaline solution to remove the silica was also considered, but the silica was found to carry down a considerable amount of vanadium. This removal had to be done upon the alkaline side and, therefore, under conditions favorable for the precipitation of many vanadates. The trouble from the silica was finally eliminated by diluting the alkaline solution and then adding to the acid, so that the resulting mixture was always on the acid side. These conditions are more favorable

for holding the silica and vanadium in solution, since it is unnecessary to pass through the neutral point to get the desired acidity.

Preference Given to Sulphuric Acid

Preference was given sulphuric acid, although a few experiments were made with nitric and hydrochloric acids. A series of runs were made with a gradually increasing acid concentration to determine the acidity best suited for the maximum recovery. The results obtained may be seen by reference to Curve I of Fig. 1.

The precipitation of the vanadium depends upon the formation of pyrovanadic acid ($H_4V_2O_7$), which is a brownish precipitate very similar to ferric hydroxide. This compound forms only in extremely dilute acid solutions when sulphuric acid is used. The experiments were then made to determine the acidity most favorable for the formation of the pyrovanadic acid, which separates out readily on boiling. Low acidities favor the formation of metal vanadates, and high acidity favors the formation of vanadium sulphates,

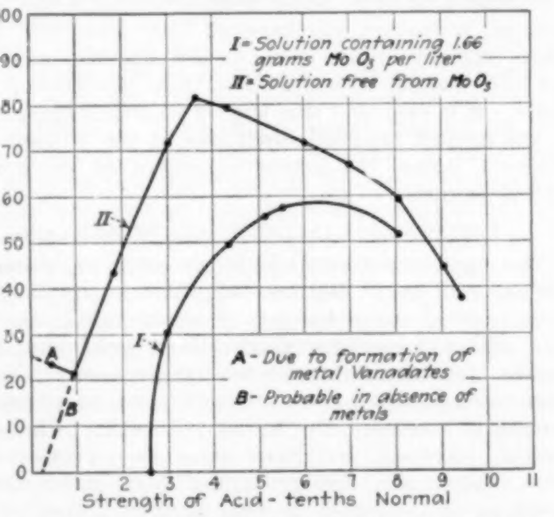


FIG. 1. CURVES SHOWING AMOUNT OF V_2O_5 PRECIPITATED BY BOILING IN SULPHURIC ACID SOLUTION 10 G. OF V_2O_5 PER LITER

which are soluble and are not thrown out of solution by boiling.

Curve I of Fig. 1 shows the results secured by using the alkaline solution obtained by leaching the slag from the fusion. This solution contains, after acidifying, silica, molybdenum and sodium sulphate as the principal impurities. No precipitation of pyrovanadic acid was obtained until the acidity became about 0.25 N, at which point precipitation began. The amount precipitated increased up to a concentration of 0.5 to 0.6 N and then decreased. The maximum recovery could not be raised above about 58 per cent. Even the addition of oxidizing agents failed to materially increase the recovery.

A synthetic solution of vanadium prepared by dissolving some pentoxide in a sodium carbonate solution showed very different results. Precipitations began at a much lower acidity and increased rapidly until a concentration of from 0.2 to 0.3 N gave a 90 per cent precipitation.

Results showed that some impurity present in the alkaline solution was responsible for the trouble. The principal impurities, silica and sodium sulphate, were successively eliminated as possibilities until some molybdic oxide was added to a synthetic sodium carbonate-pentoxide solution and an attempt made to precipitate the vanadium as before. Results obtained were:

No. of Test	Grams V_2O_5 per Liter	Acidity of Sol.	Ratio $MoO_3 : V_2O_5$	Per Cent Precipitation
1	10	3/10 N	0	87.3
2	10	3/10 N	1:6	35.1
3	10	5/10 N	0	86.9
4	10	5/10 N	1:6	65.3

The silica and sodium sulphates were found to retard slightly the precipitation of the vanadium, but the real interfering agent was the molybdenum present in a ratio to the vanadium of approximately 1 to 6, as shown in the table. The interference can be explained only by the possibility of the formation of certain soluble molybdenum-vanadium complexes. A scheme for eliminating the molybdenum was then necessary. The use of hydrogen sulphide was considered, but the precipitation of molybdenum as the sulphide is tedious and incomplete unless done under pressure. As a matter of fact, it is really a difficult analytical procedure. Another more serious objection to the use of hydrogen sulphide is that it quite readily reduces the vanadium to the tetroxide, which does not favor subsequent precipitation as the pentoxide.

The Method Recommended

The method recommended for eliminating the molybdenum is as follows:

As will be remembered, under the precipitation of the vanadium from the alkaline solution by the use of lime, it was found that the resulting calcium vanadate con-

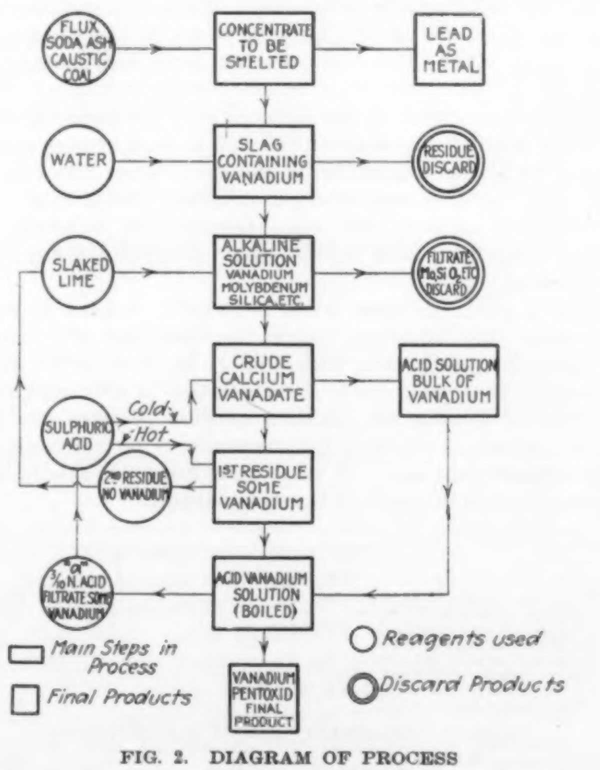


FIG. 2. DIAGRAM OF PROCESS

tained only a trace of molybdenum. This scheme was then used to dodge the molybdenum. The calcium vanadate was made by treating the alkaline solution with lime and then dissolving in sulphuric acid and throwing the vanadium out by boiling.

Curve II of Fig. 1 shows the results attained from a solution obtained in this manner. The recovery is a little lower than that from the synthetic sodium carbonate solution, but much higher than that from the alkaline solution.

The actual outline of the process finally recommended for the treatment of vanadinite concentrates is given in Fig. 2. Each ton of concentrates is smelted with 800 lb. of caustic soda, 200 lb. of soda ash, together with sufficient coal or coke to reduce the lead. The slag is then taken through the steps indicated to produce the high-grade vanadium pentoxide as a final product.

RESULTS OBTAINED ON 50 POUNDS OF ORE

Weight of ore	50.0	lb.
Weight of caustic soda	20.0	lb.
Weight of soda ash	5.0	lb.
Weight of coal	3.0	lb.
Weight of lead recovered	23.5	lb.
Percentage lead recovered	93.2	
Weight of slag recovered	42.0	lb.
Percentage of vanadium extracted	89.6	
Percentage of vanadium recovered as calcium vanadate	89.6	
Percentage of V_2O_5 in calcium vanadate after drying	13.64	
Percentage of V_2O_5 in calcium vanadate after ignition	15.90	
Percentage of V_2O_5 in final product	86.6	

The actual amount of sulphuric acid consumed in dissolving the calcium vanadate was not determined on this run, since it is necessary to make a number of successive runs to determine the acid consumption. Tests were made, however, on smaller lots, and it was found that about 60 per cent as much acid as calcium vanadate would be required. Assuming a 16 per cent calcium vanadate, it would require about 4 lb. of 60 deg. B. sulphuric for each pound of vanadium pentoxide, i.e., for chemical alone it would cost only about four or five cents per pound of vanadium pentoxide.

The grade of the final vanadium pentoxide prepared by this treatment varies from 85 to 90 per cent V_2O_5. The recovery is quite satisfactory, since it is maintained at the same level as the actual recovery of the vanadium from the slag. The only solution discarded, excepting as the volume of the solution after precipitation of V_2O_5 becomes too great, is the filtrate from the precipitation of the calcium vanadate. The actual acid consumption is large at the beginning of the cycle, since the excess of lime must be converted to sulphate along with the calcium vanadate; but when the calcium sulphate is used, very little acid is required to dissolve the calcium vanadate.

Care must be taken when the $CaSO_4$ is used to precipitate the vanadium, since the tendency of molybdenum to precipitate with $CaSO_4$ is much more pronounced than with CaO. Precipitation is only complete with $CaSO_4$ when the alkaline solution becomes neutral —a fact which accounts for the tendency of molybdenum to separate out also. A little care, however, avoids the precipitation of much of the molybdenum.

ESTIMATE ON COSTS OF TREATMENT
Per Ton of Ore

800 lb. caustic soda at $4.30 per cwt	$34.40
200 lb. soda ash at $2.90 per cwt	5.80
900 lb. 60° B. sulphuric acid at $16.00 per ton	7.20
200 lb. lime at $25.00 per ton	2.50
100 lb. coal at $2.75 per ton	.15
Cost for chemical treatment, labor	15.00
Total cost of treatment	$65.05

VALUE OF PRODUCTS AT PRESENT MARKET PRICES

930 lb. lead at $5.00 per cwt	$46.50
225 lb. vanadium pentoxide, 85-90 per cent, at $1.20 per pound	266.00
Total value of products	$312.50

To the above cost of treatment must be added the costs of mining, milling and concentrating, which are extremely variable factors, depending upon the location and facilities for mining. It would seem though that the difference between the value of the products and the costs of treatment would allow an attractive margin for the production of the concentrates.

The author wishes to gratefully acknowledge the many helpful suggestions received from Dr. S. C. Lind of the Rocky Mountain Station of the Bureau of Mines, under whose direction this work was carried on.

Golden, Colo.

Japanese Industrial Notes

THE Oriental Steel Manufacturing Co., Ltd., is making rapid progress. The smelting furnace ordered from the United States has arrived at the Tobata (Kyushu) works. When it has been installed, it is expected to have a capacity of 150 tons of iron per day.

Overproduction of Pig Iron

Japanese iron producers are now suffering from the inactivity of the iron markets due to the sudden ending of the war. The question of making an adjustment in prices has recently been officially decided. At first they intended to sell 50,000 tons of pig iron to the government. But this proposal was not accepted and the government purchase was settled limited to 13,900 tons. The sellers of iron being dissatisfied with the above amount, a further purchase of 2400 tons was made. There remains 33,700 tons unsold, and the producers are now looking forward for a third government purchase. It is said that this will by no means bring relief to the present troubled conditions of the Nippon ironmongers, unless the output is limited by the side of iron producers.

Fluctuations in the Wages of Artisans

The wages of artisans which have advanced more than 100 per cent are: Soy brewers, brick layers, Japanese cloth tailors, paper hangers, male servants, Japanese clog makers, saddlers, shipbuilders, gold and silver smiths, joiners. From 50 to 100 per cent: Coolies, gardeners, painters, sawyers, machinists, paper makers, founders, roofers. Up to 50 per cent: Plasterers, smiths, carriage builders, fishermen, confectioners, type compositors, foreign style tailors, stone masons, dyers.

Phosphate Rock

Manufacturers of phosphate fertilizers recently held a meeting at the Nihonbashi Club, Tokyo. The allocations of the following concerns were decided: Dai Nippon Artificial Fertilizer Co., Kanto Sanso Co., Nippon Fertilizer Co., Sumitomo Fertilizer Manufacturing Co., Taki Fertilizer Works, Osaka Chemical Works, Sakai Sulphuric Acid Manufacturing Co., Niigata Sulphuric Acid Manufacturing Co., Kokuriku Artificial Fertilizer Co.

Japanese Society of Chemical Industry

Japanese Society of Chemical Industry (in Japanese, Kagaku Kogyo Kyokwai) has recently been organized by eminent chemists under the auspices of Viscount Kiyoura to give an impluse to the chemical industry.

Japanese-American Syndicate for Manufacturing Aluminium

The problem of establishing a new co-operative concern under Japanese-American capital is now making great headway. The capital is said to be 10,000,000 yen and the object of the concern is to establish an aluminium manufacturing plant in Fushiki harbor, Toyama Prefecture, with the hydraulic power of the river Jintsu. The privilege of using the water for generating hydro-electric power is being arranged with Mr. Inoue, Governor of Toyama Prefecture.

Fundamental Principles to Be Considered in the Heat Treatment of Steel

Notes Recording Some of the Fundamental Principles Which a Metallurgist Should Use as a Check-List When Engaged in an Investigation of Heat Treatment, Selection of Metal, Furnaces, Heating and Quenching Practice, Pyrometry, and Physical Tests

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HEAT treatment of steel is entirely for quality, and in no case should quantity of production or cost of materials be allowed to influence a metallurgist in heat treating a given steel in an improper manner. If anything at all is done, it should be heat treated so as to give the best properties obtainable from that steel and not simply properties which will pass the minimum specifications.

There are three general types of heat treatment:

First, one type is known as softening. Within this branch come the two processes known as normalizing and annealing. Normalizing means heating the steel to a temperature exceeding its upper critical range and allowing it to cool freely in the air. The maximum temperature shall be maintained for about fifteen minutes and should exceed the upper limit of the critical range by at least 50 deg. Annealing means heating the steel above the upper critical range and allowing it to cool very slowly, such as cooling it in the furnace in lime, mica or similar non-conductive material. The object of these two processes is to remove all stresses which have been placed in the steel by previous working, and to refine the crystalline structure. In general, steel will respond more readily to hardening if it is previously subjected to a softening treatment.

The second general type of treatment is known as hardening. This means heating the steel above the upper critical range by about 50 deg. to 100 deg. and quenching in a suitable fluid, such as water, brine or oil.

The third type of treatment is tempering or drawing. Tempering means heating the steel below the critical range with the object of reducing the hardness, or increasing the toughness to a greater or less extent. This operation may be followed either by slow cooling or by water quenching without materially affecting the final results.

It is well to investigate the actual effect of water quenching after drawing for each type of steel. It is definitely known that chromium-nickel and chromium-vanadium steels, when quenched in water after drawing, show a much higher resistance to shock than when cooled slowly. In the case of straight carbon and straight nickel steels, on the other hand, the resistance to shock does not seem to be affected by the method of cooling after tempering.

Other terms often used in heat treating work are: Cementation, or case hardening; heating a steel above its normalizing temperature in a medium which will increase its carbon content; core of a case hardened bar is the interior portion of the bar which is unaffected in composition by the carbonizing process; bluing—reheating a steel to a specified temperature and allowing it to cool in air.

In the selection of steels to be used in different parts of machines, careful attention should be paid to the manner in which the part in question operates. First, the amount of stress which the piece is expected to stand should be calculated, then the factor of safety should be applied. Then the weight and size of the piece should be determined, also it should be noted whether it will be subjected to wearing, and whether it must withstand shocks or alternating stresses. After these points have been determined, the steel may be selected according to the following general specifications:

Stresses	Metal to Be Used	Composition
Parts subjected to but slight or practically to no stresses or wear.	Medium carbon steel (when aluminium alloys are not permissible).	C, 0.30 to 0.40% Mn, not over 0.75% P, not over 0.05% S, not over 0.05%
Severe wear, but not severe fatigue stresses.	Low carbon steel suitable for case hardening.	C, not over 0.20% Mn, not over 0.50% P, not over 0.05% S, not over 0.05%
Severe wear and severe fatigue stresses.	Low carbon nickel-chromium steel suitable for case hardening.	C, not over 0.20% Mn, not over 0.50% P, not over 0.05% S, not over 0.05% Ni, not less than .... 2.00% Cr, not less than .. 0.50%
Severe fatigue stresses, but not severe wear.	Medium hard nickel-chromium steel.	C, 0.30 to 0.40% Mn, not over 0.75% P, not over 0.05% S, not over 0.05% Ni, 2.50 to 3.50% Cr, 0.50 to 1.00%
Severe fatigue stresses or wear or both, when smaller ductility is permissible.	Self-hardening nickel-chromium steel.	C, 0.30 to 0.50% Mn, not over 0.75% P, not over 0.05% S, not over 0.05% Ni, 3.00 to 4.50% Cr, 0.50 to 2.00%
Distortion and softening at high temperature valves.	Tungsten high speed steel.	C, 0.40 to 0.70% Mn, 0.20 to 0.40% W, 12 to 18% Cr, 2 to 4% Va, 0 to 1%

In order to heat treat material, it is absolutely essential to have accurate chemical analysis of the material to start with. It is possible to equip a chemical laboratory for the analysis of all types of alloy steels for about $1500. This includes electrical combustion furnaces for the determination of carbon, but it does not contain any equipment for determining elements by electrolysis.

If the chemical analysis is carefully made, the carbon determination should be accurate to within two points of either side of the true amount. The accuracy in determining all other elements should be in the same ratio. Quite often failures in heat treatment are blamed on inaccurate chemical analyses. About 75 per cent of these complaints can be explained by investigating the actual treatment given the material; in some few instances, the chemical analysis will be found in error.

The success of any heat treatment depends, to a great extent, upon the type of furnace used. Every furnace should be such that the material being heated will receive a uniform heat at all parts and should be capable of accurate temperature control. Fuel economy should always be a secondary consideration.

Care should be taken to see that the furnace, whatever the type may be, is large enough to hold the work, and large enough so that the temperature is not materially reduced when the cold metal is placed in it. It should be so built that the work will receive an enveloping heat, and not a concentrated heat from the flame. In case the furnace is overfired, the temperature gradient of the furnace should be watched carefully and care taken that the floor is kept up to heat.

Furnaces are generally heated either by oil, gas or electricity. Oil firing is satisfactory for large furnaces where an accurate temperature control is not required and where an oxidizing atmosphere is not detrimental. Gas-fired furnaces are capable of more delicate control, both regarding temperature and the oxidizing nature of the burning gases. In case either of the above fuels are used, care should be taken to see that there is proper space in the furnace appropriated for a combustion chamber, and that the hot gases do not strike one part of the material more than another. Electric furnaces are capable of very accurate control. In cases where delicate heat treatment is being done, and where the rejection of a furnace-load of material would be costly, it pays to install this type of apparatus.

Judging a Furnace

In judging any furnace, the following things should be borne in mind:

1. Uniformity of heat.
2. Rate of heating.
3. Method of loading and unloading.
4. Quenching arrangements.
5. Initial cost.
6. Upkeep and repair.
7. Thermal efficiency.

In cases where large quantities of material are to be heat treated, it is well to consider a continuous furnace for the work, but care should be taken that it is long enough to insure uniform heating. If large material is to be rolled through the furnace, the underfired furnace will be found well adapted to the work. In case the material is conveyed through the furnace on trays, the overfired muffle furnace will be found satisfactory. Conditions cannot be controlled very accurately in continuous furnaces.

For heat treating small miscellaneous parts, the ordinary underfired tool-room furnace of sufficient size has been found very satisfactory. In all cases, the material should be piled loosely, allowing a good circulation of gases, and the furnace should not be overloaded.

Speed of Heating

In general, it is permissible to bring the steel up to temperature quite rapidly. In the case of large forgings, however, it is necessary to heat them more slowly. If the outside of such forgings heats too rapidly, it will expand and cause severe tensile stresses in the material. It is thought by some metallurgists that rapid heating has developed "flakes" in nickel steel gun forgings.

The time required to bring any piece of steel up to the desired temperature and the actual temperature desired are questions which have to be settled for each individual case. In general, when hardening, the metal should be quenched as soon as it has reached the desired temperature and has soaked long enough so that the temperature is uniform throughout. In the case of drawing, the material should be held at the desired maximum temperature as long as practical. In cases where very accurate work is desired on small parts, lead baths or salt baths are used for heating the material. Where trouble is experienced with the lead sticking to the material, this can be avoided by first dipping the steel in a solution of potassium cyanide.

Quenching Practice

Quenching tanks should be placed close to the hardening furnaces and arrangements should be made to transfer the hot metal into the liquid as rapidly as possible. Tanks should be covered with a steel lid when not in use.

Every tank should be provided with equipment to circulate and cool the quenching medium. It is better to have a small quenching tank with a high rate of circulation than a larger tank with a slower rate. The oil may be cooled by passing it through a refrigerating machine, by piping it through cold running water, or by cooling with air. In cases where a great many small parts are quenched in a tank at once, provision should be made to have the oil circulate freely among the different parts, or uniform results will naturally not be obtained.

Quenching Media

The most common quenching media are oil, water and brine. Hot lead has been used in some instances, also soap solutions and mixtures of oil and water. Brine gives the harshest quench of all, water next, then the various grades of oil. There is, however, quite a wide gap between the results obtained from water and oil.

Quenching should be considered as a rapid removal of heat from the material down to a temperature of about 500 deg. The rate of cooling steel through the critical range determines the hardness of the material in practice. This rate of cooling has a marked effect on the final physical properties of the steel after it is drawn. Thus, in general, the harsher the quench, the higher the elastic limit will be, in comparison with the tensile strength, but the ductility does not seem to be materially affected.

If water or brine is used as a quenching medium, its temperature should be above 100 deg. F. In case of large forgings, this temperature may be from 100 to 110 deg., while for smaller forgings, it should be increased to 150 or 200 deg.

In using water or brine, there is great danger of developing quenching cracks or of warping the material. For this reason the steel should be immersed in the quenching medium in line with its longitudinal axis, and should be removed when it has reached a temperature of about 500 deg. F. since most of the cracks and warping occur as the steel is quickly cooled below this temperature. There is also danger of developing steam pockets; the steam acts as a heat insulator and causes soft spots in the steel. Only forgings which are symmetrical and of considerable size should be quenched in water.

In general, it is better and safer to quench in oil, providing this medium will give a harsh quench enough

to produce the desired properties. A good quenching oil should not deteriorate upon use, and is judged according to the following physical properties:

1. Specific heat.
2. Heat conductivity.
3. Specific gravity.
4. Viscosity.
5. Flash point.

The temperature of the quenching oil should be over 100 deg. The actual temperature of the medium seems to have little effect on the physical properties of the hardened steel; still it is much more economical to maintain the oil at about 150 deg. and it pays to install sufficient cooling area to keep the oil at this temperature. One gal. of high-grade quenching oil, when used under economical conditions, should quench about 1500 lb. of steel—this figure is contingent on the size and nature of the pieces. Steel taken from oil should be placed on tables, so that the oil will drain back into the tank.

Pyrometric Control

In order to heat treat material intelligently and to obtain uniform results, it is necessary to have all the furnaces adequately equipped with pyrometers.

Base metal thermocouples are commonly made of iron and constantin wire, or chromel and alumel wire. The iron-constantin couple seems to be somewhat more accurate, but it does not seem to have as long a life as the chromel-alumel couple. The platinum-platinum rhodium couple is the most accurate, but the cost of the rare metals makes them prohibitive for commercial use, except for controls.

Electrical meters usually record the potential difference between the hot end of the thermocouple and its cold junction. It is absolutely essential to have the cold junctions of any pyrometric system located in such a place that its temperature will remain practically constant. This can be accomplished most readily by burying them in the ground at a distance of 4 or 5 ft. from the furnace. However, other arrangements which provide a constant temperature are satisfactory.

There are two general types of meters. One is a low-resistance instrument (milliammeter or galvanometer) and the other a high-resistance instrument (millivoltmeter). The low-resistance instrument is more robust than the other, but it is effected to a greater extent by variations in the resistance of the leads, poor connections, etc.

For more accurate work a potentiometer with an iron-constantin couple seems to give good results. This instrument can also be used with couples made of any other combination of metals, since in this system, an electromotive force is introduced into the circuit which just counteracts the electromotive force generated in the thermocouple. When the indicator on the potentiometer shows that no current is flowing, the amount of electromotive force introduced is read and transferred into degrees by the use of a calibration chart. This type of installation is not affected by the resistance of the leads or by oxidation of the thermocouple. It registers accurately as long as part of the weld in the thermocouple holds together.

Any pyrometric system is only as accurate as the calibrating and checking equipment available. Thermocouples should be checked at least once a week, preferably by placing a standard base metal couple beside thermocouples that are being used in furnaces and reading temperatures registered by the two. The standard base metal couple should also be periodically checked in an electric furnace against a standard rare metal couple, or it may also be checked by melting points. In this case, care should be taken that the melts are pure and that it is used in a graphite or ceramic container. Iron tubes should not be used in the salt bath. A vertical electric furnace about 3 ft. long and 3 in. in diameter will be found well adapted to such work.

Placing the thermocouple in the furnace is very important. Care should be taken that the temperature at the end of the thermocouple is the same as that of the material being heat treated. (This can be checked in hardening furnaces by use of an optical pyrometer—the Leeds Northrup pyrometer is very satisfactory for this work.) If the pyrometer reads 1550 deg., it is no proof that the material is at this temperature, but if thermocouples are properly installed and checked, one should be able to control the temperature of the material to within 10 deg. on either side of that desired. In general, however, the temperature is rarely controlled within a range of 20 deg. plus or minus.

Physical Tests

After the material has been heat treated, it should be subjected to some sort of a physical test, the tensile test being universally used. When the test bar is pulled, the elastic limit, tensile strength, per cent elongation and per cent reduction of area should be calculated and recorded, together with the nature of the fracture.

The elastic limit may be determined in several different ways, the most accurate method being the "increment" method. This consists in clamping an extensometer on the test bar and noting the stretch as each 1000 lb. per sq.in. load is added to the bar. The point at which the stretch ceases to be proportional to the added load is taken as the elastic limit to the specimen.

Other methods for getting the elastic limit are the "run extensometer" method, "scribe" method, "modified scribe" method and "drop of the beam." In the "modified scribe" method, the test specimen is first scribed with dividers set at a length equal to the gage length of the test specimen, one end of the divider being set in a punch mark on the specimen. A load corresponding to the minimum elastic limit required for the material is then applied, care being taken that the beam balances under this load. The load is then released and the test specimen is scribed again. If after this second scribing two distinct lines are seen, the elastic limit is considered as having been exceeded, while in case there is no permanent set in the specimen, the elastic limit has not yet been reached.

Per cent elongation and per cent reduction of area are an indication of ductility. Per cent elongation is contingent upon the relation between the original area of the specimen and the gage length, and the following general relation should exist:

$y^2 = 20x$, where y is the gage length and x is the area of the test piece.

Number of Tensile Tests

The number of tensile tests that should be taken from any lot depends entirely on the importance of the properties measured by this test as related to the stresses set up in the piece when in operation.

Compression tests are often made on steel and cast iron in order to obtain information as to the amount of direct loading the material will stand and also as a

measure of the ductility of the material. A compression test specimen is usually a cylinder, whose diameter is equal to its height. The specimen is then compressed to one-half of its original height if it does not break before that point. The elastic limit in compression can be determined the same as in tension.

Bending tests are often made to determine the ductility of steel. This test generally consists of bending the piece flat about a rod whose diameter is equal to the thickness of the piece.

Torsion tests are also made in a twisting machine which measures the amount of force required to twist the steel to a certain angle. This test is applied to steel which is to be used for axles, crank shafts or similar work.

Fatigue tests are often made on steel to determine the amount of alternating stresses the material will stand before breaking. This test generally consists of rapidly bending a piece of steel back and forth without exceeding the elastic limit, and measuring the number of such bends required to break the material.

Shearing Tests

Shearing tests are often made on steel which is required to stand up under shearing stresses. In this test, a specimen is broken in a machine which measures the force required to shear a standard specimen in two. This force is then divided by cross-section area.

Impact tests should be made on all material which will be subjected to shocks. The most common types of impact machines are the Izod and the Charpy. Both have a heavy pendulum, which swings from a certain height and breaks the specimen, the amount of energy remaining in the pendulum being measured by the distance which it swings after striking the specimen. It is very important to have the specimens accurately machined for this test, and if it is notched, it should be done on a special milling machine which is used only for this one purpose.

Drop Tests

A drop test is often used on cast iron and steel. This consists of dropping a weight from a specified height repeatedly until the material breaks, or by starting at a specified height and increasing the drop by a certain increment each time until failure. The test bar is supported on knife edges, the radii of which have a very important influence on the results.

It is impossible to estimate the impact resistance of a piece of steel by any other test; that is, steel which has the same chemical analysis when heat treated in different ways may give exactly the same tensile properties, but have entirely different resistance to shock. This is particularly true of steels containing chromium and vanadium.

The hardness of steel is measured in several different ways. The Brinell test consists in applying a weight of 3000 kg. through a 10 mm. steel ball upon the material for 30 sec. The diameter of the impression is then read by a microscope, and the hardness number taken out of a table. This test is fairly indicative of the tensile strength of the material. From the Brinell number, knowing the chemical analysis of the steel, one should be able to estimate the tensile strength to within 5000 lb. per sq.in. It is also an excellent test to check the uniformity of heat treatment. In testing a lot of material, it is well to Brinell a portion of them and then select the softest one for tensile tests. In this way it is certain that the softest piece in the lot meets the physical requirements.

Hardness may also be tested by the Shore scleroscope. In this test a tiny pointed hammer is dropped on the material from a certain height and the height of rebound is measured. The surface tested should be carefully smoothed and the small hammer should not drop twice in the same place. The piece being tested should also be supported solidly. The results of this test cannot be interpreted to read elastic limit, tensile strength or Brinell hardness with any degree of accuracy; however, there is a very general relationship between these properties.

Special tests are often made on small heat treated parts on specially designed machines, which aim to set up stresses in the piece similar to the ones it will be required to resist in operation. These tests are either run until the piece breaks, or until it has withstood the tests for a specified time. Such tests are very satisfactory and should be applied wherever possible.

Micrography

Microscopic examination of steel is of great assistance to a metallurgist, and at times indispensable. For tracing causes of failures and for laying out heat treatment for new parts, such examination can be used to great advantage.

A cubical specimen about ¾ in. on a side is about the best size to handle in polishing. One surface should be ground or filed flat. It should then be polished on a regular polishing wheel until all scratches are taken out. It is well to examine a surface under a microscope before etching. The specimen can then be etched in a 5 per cent solution of nitric acid and alcohol, or a 10 per cent solution picric acid in alcohol.

Any examination of steel is really incomplete without the microscope. It is an excellent check on all other tests and analyses. Before making any definite statements concerning the structure of the steel, the chemical analysis should be known, together with the heat treatment the material has received.

Conclusion

As stated in the first part of this paper, heat treatment work is entirely quality work. In order to accomplish this, it is necessary that every man working in the heat treatment department be intensely interested in his work. In order to maintain the interest of the men, it is necessary that every man should be educated as much as possible in the line of work he is handling and should view his work at all times with an inquiring attitude. Each man should be encouraged to think about the work he is handling and should be allowed to exercise the creative side of his nature whenever possible. Responsibility should also be placed upon the men who are actually performing the operation; this can be accomplish by allowing the men to visualize their work by the use of graphs and charts. Interest can be maintained by keeping progress reports of the men throughout definite periods. These records should be open to the men at all times; they should be kept only with the idea of showing the men to what extent they have mastered the work they are handling, and to see the comparison between what they and the other men are doing. When the heat treatment department is organized on these principles, the maximum production will be obtained with the best quality.

Cost information, similar to the following, should be available to the metallurgist:

1. Direct labor cost.
2. Indirect labor.
3. Overhead.
4. Price of materials used.
5. Quantity of material heat treated.
6. Quality of material heat treated.
7. Quantity of material quenched per gallon of quenching oil used.
8. Cost per unit weight of material heat treated.

These figures should be carried forward on chart record.

Rochester, N. Y.

Determination of Uranium, Zirconium, Chromium, Vanadium and Aluminium in Steel—I

By Charles Morris Johnson

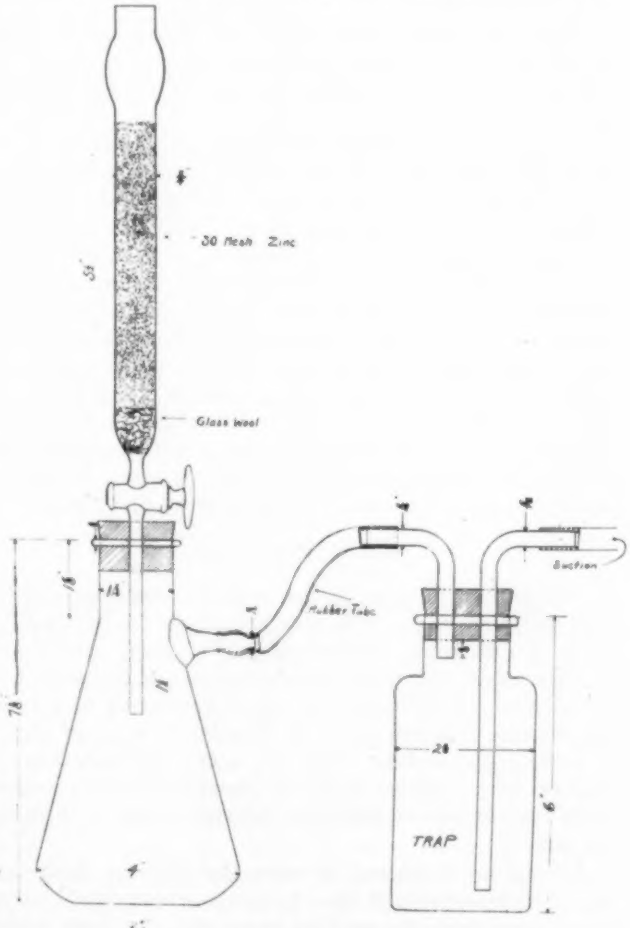
THE feature of the following method is to remove the bulk of the iron from the uranium, zirconium and aluminium before making determinations of these elements by fractional precipitation by ammonia. The analysis can then be proceeded with in a simple and accurate way. The separation of the bulk of the iron is based on the fact that when ammonia is added to iron in the ferrous state the unoxidized iron is first converted to double sulphate of ferrous iron and ammonium and remains in solution. By adding the ammonia very slowly with constant stirring a point in the neutralization is reached where a slight reddish precipitate forms. On the addition of a few drops more of ammonia this reddish precipitate darkens. At this stage all the aluminium, zirconium, uranium, etc., are precipitated, while 99 per cent of the total iron remains in solution as double sulphate and is removed by filtration. By actual test with 10 g. of plain steel to which uranium salt was added, over 99 per cent of the iron was removed.

Uranium in Plain Steel

Dissolve on a low flame 5 g. of drillings in 50 cc. 1: 3 sulphuric acid diluted with 50 cc. of water, using a 600 cc. beaker. For steel containing less than 0.1 per cent uranium use 10 g. of sample. When action is over, filter off the insoluble residue, which is mainly carbide, and wash it 25 times with dilute sulphuric wash (25 cc. of 1: 3 H_2SO_4 diluted with water to 600 cc.). Call this filtrate and washings *A*. The insoluble residue may contain U, so it must be ashed in a platinum crucible at a low heat; cooled; 6 cc. of HF plus 6 cc. of 1 : 3 sulphuric acid added; evaporated to thick fumes of SO_3; cooled; a little water added; heated to dissolve the sulphates and the clear solution is added to *A*. Then dilute to 250 cc. volume with water and add 1: 1 ammonia with constant stirring until a slight precipitate forms. Then continue to add ammonia drop by drop until the precipitate just begins to take on a blackish tint. At this stage all the uranium has been precipitated with only a small portion of the iron.

To assure a complete precipitation of the uranium, add about 10 more drops, but do not exceed 10 drops, as excess ammonia only brings down a greater bulk of the iron. Filter off the precipitate at once on a double 15 cc. filter paper and redissolve it in 50 cc. 1: 1 HCl. First warm up the acid in the beaker to dissolve any iron that sticks to the sides; then pour the hot acid on the precipitate, catching the filtrate in a 600 cc. beaker. Pour hot filtrate on the filter two or three times until all the iron is in solution. Wash the filter paper about 25 times with dilute HCl wash (1: 40). Now peroxidize the filtrate and washings by adding, slowly, with a porcelain spoon, about 1 g. of sodium peroxide at a time. After each addition wash off the sides of the beaker with water and stir the solution well. Keep on peroxidizing until all the iron is precipitated and the solution is alkaline when tested with red litmus paper.

Now add about 5 g. of sodium carbonate and 5 g. of ammonium carbonate to keep the uranium in solution.



REDUCTOR FOR U AND FE

Stir well and bring it just to a boil. Filter off the iron and wash it about 25 times with sodium and ammonium carbonate wash (2 g. of Na_2CO_3 and 2 g. of $(NH_4)_2CO_3$ dissolved in 600 cc. of water). To the filtrate which contains all the uranium add 1: 1 HCl with stirring, till solution no longer turns turmeric paper even a faint brown, but still reacts alkaline when tested with red litmus paper. Keep the beaker covered when adding the acid, as the effervescence is very strong, especially toward the end of the neutralization. Boil off the CO_2 and then add slowly with stirring (keeping the beaker covered) 1: 1 HCl till the solution is slightly acid. No more effervescence at this stage, but the acid falls down to the bottom of the beaker without action.

Boil the acid solution for half an hour to remove CO_2 and after it has been cooled add 5 g. of ammonium phosphate $(NH_4)_2HPO_4$; stir till dissolved; then add 1: 1 ammonia till it smells ammoniacal and add 1: 1

acetic acid till the solution is acid; now add 5 cc. acetic acid in excess. The acetic acid keeps any chromium and vanadium present in solution. Chromium does not interfere with the uranium titration, but vanadium interferes greatly.

After a few hours, filter off the uranium and wash it about 40 times with acetic wash (5 cc. of ammonium phosphate, 10 cc. 1: 3 H_2SO_4 diluted with 100 cc. of water, stir till dissolved, make it slightly ammoniacal and then acid with acetic acid 5 cc. in excess. Dilute with water to 600 cc.). Redissolve the uranium in 50 cc. hot 1: 3 H_2SO_4 by pouring the hot acid back and forth two or three times on the precipitate, catching the filtrate in a 400 cc. beaker.

Wash the filter paper about 30 times with dilute H_2SO_4 water. In high vanadium steel it is better to test for vanadium by adding 5 cc. of H_2O_2 to the solution and noticing whether it changes to brown; if it does, make another ammonium phosphate precipitation to remove the vanadium. If the solution does not change in color, bring it to a boil; then add several drops of $KMnO_4$ till it gets a pink color that will not fade after 15 min. boiling. Cool the oxidized solution to room temperature. Now reduce the uranium by passing it slowly through a zinc reductor and immediately titrate the reduced solution with a standard $KMnO_4$ solution to the first appearance of pink that spreads all through the solution. If there is any vanadium in the solution at this stage the pink will disappear in about 5 sec. instead of holding one minute. Any more permanganate added that disappears after 5 sec. standing is due to vanadium that has been carried over as phosphate.

Jones Reductor

The column of zinc in the reductor rests on a ¾-in. plug of glass wool. The zinc column is 5½ in. long by ¾ in. in diameter consisting of 30 mesh grains of amalgamated zinc. The amalgamation is accomplished by stirring the 30 mesh zinc under a covering of mercuric chloride solution made by dissolving 50 g. of $HgCl_2$ in 1000 cc. of water. The zinc after amalgamation is washed with distilled water by decantation in a beaker until free of excess mercuric chloride, when it is ready for use.

A trap jar is placed between the filtering flask and the suction to prevent back pressure which would carry water over from the suction pump into the flask which holds the filtered, reduced, solution of uranium. The volume of the uranium solution to be reduced is about 50 cc. This is passed through reductor slowly, i.e., at the rate of 50 cc. per 10 minutes.

After passing the solution through the reductor, wash the zinc with dilute H_2SO_4 (1: 6) three times, 10 cc. each time, and then three times more with 10 cc. of water each time; drawing off each washing completely before adding next washing. The volume before titrating is about 100 to 110 cc.

For convenient calculation 2.29 g. $KMnO_4$ are dissolved in distilled water and diluted to four liters.

1 cc. $KMnO_4$ Standard = 0.002169 gram U.

1 cc. $KMnO_4$ Standard = 0.001014 gram Fe.

The standard $KMnO_4$ can be checked for its uranium and iron value by titrating it against sodium oxalate.

Uranium in Chrome Tungsten Steel

Dissolve 5 g. of steel in 50 cc. of 1: 3 H_2SO_4 diluted with 50 cc. of water; after action is over, filter off the insoluble residue and dilute the filtrate to about 250 cc. volume with water. Now add 1: 1 ammonium with constant stirring until the precipitate at first takes a reddish tint, next changing to a blackish and finally to a bluish-whitish. At this stage add about 2 cc. of ammonia with stirring to complete the precipitation of all the uranium in the filtrate with only a small portion of the iron. Filter it off at once and finish as in plain uranium steel.

The insoluble tungsten and chromium carbide residue on the filter was found to contain some of the uranium. Wash it off the filter paper with dilute sulphuric acid into the original beaker, heat it, and then oxidize it with 30 cc. of 1.20 nitric acid. Keep on heating on a low flame until the residue is bright yellow. Filter off the tungsten, wash it about 25 times with dilute H_2SO_4 wash; and peroxidize the filtrate with sodium peroxide to separate the uranium from the iron. Catch the uranium filtrate from the main peroxidation and that from peroxidation of the insoluble residue in the same 800 cc. beaker and finish as in plain steel.

A variety of mixtures was tested by adding different portions of uranium acetate (56.13 per cent). The results are given below.

TABLE SHOWING URANIUM ADDED AND FOUND TO 10 GRAM SAMPLE OF PLAIN STEEL

Added Gram Uranium	Found Gram Uranium
0.0112	0.0119
0.0143	0.0143
0.0168	0.0169
0.0280	0.0286
0.0561	0.0573
0.0056	0.0055
0.0084	0.0085

Ten grams of plain carbon steel—no uranium added.

$KMnO_4$ 1.2 cc. reading of burette after titration.

$KMnO_4$ 0.0 cc. reading of burette before titration.

$KMnO_4$ 1.2 cc. = blank which is deducted.

Uranium, chromium and iron mixture; chromium added as $K_2Cr_2O_7$ to 10 gram sample of plain steel before dissolving same in H_2SO_4.

TABLE SHOWING URANIUM ADDED AND FOUND TO 10 GRAM SAMPLE OF STEEL

Added Gram	Found Gram
0.0056	0.0057
0.0084	0.0085
0.0280	0.0286
0.0561	0.0558

TABLE SHOWING URANIUM ADDED AND FOUND TO 5 GRAM SAMPLE OF TUNGSTEN, CHROME, VANADIUM STEEL

Added Gram	Found Gram
0.0112	0.0113
0.0280	0.0278
0.0561	0.0575

Five grams—no uranium added.

1.8 cc. reading of burette after titration.

0.0 cc. reading of burette before titration.

1.8 cc. = blank which is deducted.

About 80 per cent of the iron is removed by ammonia precipitation in the filtrate when large amounts of carbides of tungsten, chrome and vanadium are present, as was found by actual test. The bulk of the 20 per cent of iron that remains to be separated by peroxidation is found in the carbide residues of these steels.

Crucible Steel Co. of America.
Pittsburgh, Pa.

Continuous Distillation of Tar

According to *Commerce Reports*, May 6, the Hird process for the continuous distillation of tar is being used successfully in England, Japan and Australia, 130 plants having been erected at a cost of about $1,500,000. In England, this process is rapidly superseding all processes hitherto used.

Sintering Zinc Residues

A Description of One of the Methods Used by the Bartlesville Zinc Co. to Recover Values From Zinc Retort Residues—Most Excellent Blast-Furnace Material Containing Values in Gold, Silver and Lead Is Made From Oxidized Fines With No Fuel Additions

BY K. STOCK

ZINC ores and concentrates from the Rocky Mountain region containing various amounts of lead, copper, gold and silver are treated at the zinc smelters of the American Metal Co., located at Bartlesville, Okla. After roasting and retorting in the usual way, all residues, now containing not more than about 6 per cent of their original zinc contents, are subjected to an additional treatment depending upon the amount and nature of other metals to be recovered. For instance, a residue low in gold and silver, when admixed with complex zinc-lead ores, is burned on a Wetherill grate to a discarded clinker and a valuable fume of lead sulphate and zinc oxide. Retort residues ("ashes," so called) higher in gold and silver are clinkered in heaps, after the Petraeus patents, producing a most excellent, porous blast-furnace material (Fig. 1) with no other fuel than the excess carbon remaining from the distillation.

METAL LOSSES

Residues are selected so that the resulting sinter shall have a lead content as much above 5 per cent as possible (even after a moderate volatilization loss during the operation), 5 per cent being the minimum limit for payment according to smelter schedules. Zinc burns off to a rather larger extent than does lead, but even so the clinker may run above 10 per cent at times and be assessed a corresponding penalty. Copper, gold and silver show virtually no losses unless large blowholes in the burning pile are left untended, when the silver values especially will show an unusual deficit. To be specific, a typical residue charged on a heap may be a mixture of Butte and Cœur d'Alene residues of the following compositions:

	Butte Residue Per Cent	Coeur d'Alene Residue Per Cent
Zn	10.2	7.5
Fe	7.2	11.0
Mn	0.7	0.4
Pb	4.7	9.0
Insoluble	30.0	27.5
Cu	0.6	0.2
Carbon	35.0	30.0
Ag	37 oz.	6 oz.

TYPICAL CLINKER ANALYSIS

Such residues are mixed on a pile "as they come." Straight Butte residue is too low in lead for payment, while straight Cœur d'Alene residue has so much lead that it softens and does not sinter well. A typical clinker analyzes as follows:

	Per Cent		Per Cent
Zn	12.0	SiO_2	38.0
Fe	12.9	Cu	0.8
Mn	1.1	C	1.2
Pb	9.8	Ag	27 oz.

Naturally the clinker will vary considerably from these figures, depending upon the relative proportion of the main constituents which find their way into the bed.

Metallurgical balance sheets for a couple of years show the following losses:

	Per Cent		Per Cent
Shrinkage in weight	32.0	Pb	— 8.9
Au	— 2.8	Zn	—18.1
Ag	— 3.2	Fe	— 2.8
Cu	+ 1.4	Mn	— 7.2

Of these losses, those in silver, lead and zinc represent principally volatilization losses, while those of other metals are largely due to dusting and windage. Gain in copper is probably due to analytical errors (our residues ordinarily are quite low in this metal), while the figures for gold, iron and manganese are probably subjected to the same error, at least to as great an extent. Volatilization of a large percentage of zinc is naturally desirable, since we are making lead blast-furnace material, but an accompanying loss in lead and silver counteracts the gain.

During the operation the weight is diminished almost entirely by the elimination of carbon, so that 100 lb. of fine, bulky "ashes" will produce 68 lb. of scoria, as noted above.

BUILDING THE KILN

The clinkering beds or "kilns" are each 47 to 50 ft. square at the bottom, and are ranged in a long row, skirted on one side by an air main and on the other by tracks for locomotive crane and railroad cars (Fig. 2). The site is prepared by carefully leveling the earth and building a series of air channels of loose brick, covering the area like a gridiron, as is sketched in Fig. 3, and shown in the foreground of Fig. 2. At the rear center of the pile a long-radius bend of 12-in. riveted pipe leads from the air main to a breeching built of brick or tile bats, cemented and covered with a fairly large mound of earth to prevent air-leakage or damage from clinker removal. This breeching divides the air

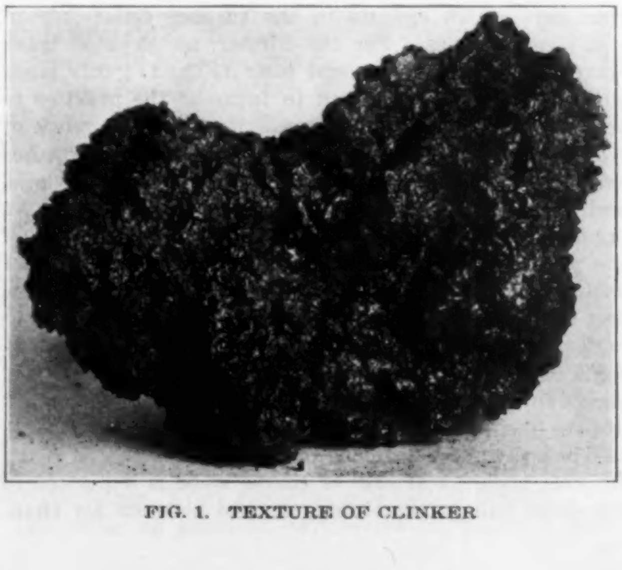


FIG. 1. TEXTURE OF CLINKER

FIG. 2. LOOKING DOWN A ROW OF CLINKERING BEDS

current into a header leading to right and left along the back of the pile and parallel to the air main, which header is constructed as follows: The central third is composed of two walls of closely dry-laid brick, four courses high and 4 in. apart, while the end portions are built but three courses high. The roof merely consists of square brick or tile closely laid to exclude infiltering fines. At intervals of 3½ ft. a half-brick is removed from the front wall, from which openings the minor channels lead clear across the pile toward the front. These channels, 13 in number, are somewhat similar to the headers; they are built of dry brickwork, the bottom courses consisting of half-bricks, however, while the top courses and roof are tight. This provides a great many relatively large openings through which the air blast may find its way out into the pile above. All these channels are then covered with a thin ridge of earth, patted down with a flat shovel, and the area is ready for ashes.

Two men are required to perform the work of smoothing down the ground, building and covering the air channels.

Retort residues are brought to the heaps either in the tram-cars which operate in the furnace cellars, or in standard gondolas. For the former, an elevated track traverses the site of several piles (Fig. 2); this track will probably be dismantled in favor of the practice to be immediately described, thus eliminating the work of two trammers. Railway cars, filled with residue ashes through traps, are switched to the site of a new pile, and approximately 100 tons are unloaded by locomotive crane and clam-shell bucket in a ridge at the rear of the pile, as shown in Fig. 4, covering the back header with the toe of the slope occupying the position a few feet beyond the channels sketched in Fig. 3. Two more carloads are piled along the front of the heap, thus leaving a trough across the area midway from front to back, where for a short distance all of the 13 parallel channels are yet uncovered.

When two more carloads of residue are spotted ready for this heap, an armful of coarse wood is deposited in the short valleys remaining exposed between air channels, a shovelful of hot coals placed on the wood, and the whole covered with residue from the adjoining slope. When a row of fires is kindled in this manner across the pile, a little air is admitted by raising the slide gate somewhat, and the locomotive crane proceeds to unload the two cars into the trough, finishing out a square pile which when trimmed off becomes about 5 ft. deep (Fig. 5). By this time the air gate is wide open, and the blast, working its way through the earth channel-coverings, fans the coals and kindlings into life; thence the combustion expands through the mass in all directions.

Within a few hours smoke begins to emerge from an area across the center of the pile, gradually widening as the fire works its way from the points of kindling. Within a week it has extended to the entire area of the pile, and the center, burning since the first, has sunken somewhat. This depression is kept level, however, by adding more ashes, in order that the resistance to escaping blast may be approximately the same in all parts. All burning piles are inspected several times each 24 hours, and any blowholes which may appear are smothered under a small heap of fresh residue. As combustion proceeds and the pile settles, a new carload of ashes is spread over the surface, this practice continuing until four to six extra carloads of residue have been added, making a total of 500 to 600 tons residue in one heap. Despite tight construction of the header, the rear portion of the pile burns more rapidly than the front, and consequently the unburned additions are spread much more liberally on this region, and the clinkered mass is deeper in consequence.

After about a month the pile has been built to its maximum depth and pretty thoroughly burned. Fire constantly breaks through at so many different places that one man spends the largest part of his time digging out the black sandy residue from unburned spots and heaping it over the tiny volcano craters. During this last stage, the surface of the pile becomes naturally very irregular (Fig. 6)—mounds cover these places where for some reason or other the blast was most effective,

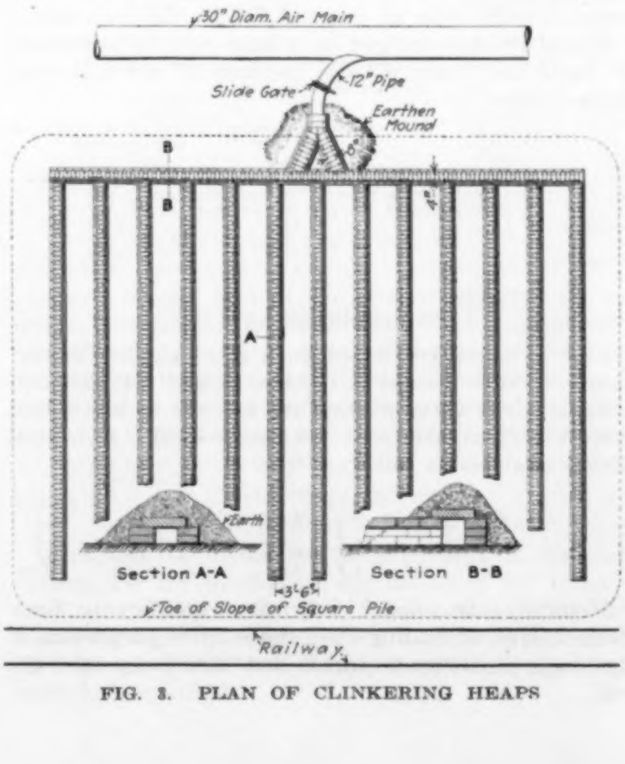


FIG. 3. PLAN OF CLINKERING HEAPS

FIG. 4. AIR CHANNELS COMPLETED AND FIRST CARLOAD OF RESIDUE UNLOADED

while other portions of the pile where little air penetrated are almost denuded of material. As the unburned cover becomes thinner the air supply is gradually reduced, and at the end of the operation the surface of the pile is a brownish granular mass, covering the sintered material to a depth of a couple of inches. This covering, although having lost the large part of its carbonaceous material, radiated its generated heat so rapidly that fusion was impossible.

For all work in trimming up the piles, five day men and one night man are employed. While actually on a burning pile, the workmen move about on short pieces of plank, so that their weight may not break through into an incandescent cavity, which sometimes exists several feet in diameter.

Loading Clinker

Burning a pile thus requires in the neighborhood of 35 days. When this stage is finished, the air is completely shut off, and a garden hose set so as to sprinkle water over the surface, wetting continuously for three days before the pile is cool enough to handle. Speedy cooling is of advantage further than as a time saver, since slowly cooled clinker is very tough, while quenched clinker breaks more easily. The pile now consists of a large thick clinker, more or less continuous, covered by a thin blanket of unconsolidated fines, but in all much too solid for removal by hand or machinery. Consequently the pile is broken up with powder.

A 2-in. bar is driven down to the ground level at intervals of about 5 ft. between each pair of air channels. On removal of the bar the hole is inspected, and if there is reason to suspect that the material at the bottom is not quite cold, water is hosed into it for some time. A line of cold holes is then loaded with a stick of dynamite in each, some fine material sifted in for tamping, and the charge fired with slow-burning fuse. The powder charge is naturally varied according to conditions—the idea being to lift the mass but slightly, cracking it into one-man size, without throwing even the fines more than a few feet. A crew of seven men then attack the broken pile with sledge, pick and shovel, moving the sinter a few feet to the rear on clean ground, separating out the earth covering from the air channels and reclaiming the brick.

FIG. 5. COMPLETED HEAP

A locomotive crane then loads this piled clinker by means of a clam-shell bucket and the area is ready for rebuilding the air channels. Unsuccessful trials demonstrated that this style of bucket, even when equipped with teeth, was totally unable to dig the pile after it had been broken up with powder. While an orange-peel bucket would doubtless handle such material, considerable time would be required to make the frequent changes in buckets, since this style is unsuitable for unloading cars, which, in fact, is the most essential part of the cranes' duties. Even so, digging by machine must stop at a level a few inches above the tops of the air channels in order to avoid loading a large tonnage of earth cover and bats, leaving the balance of the clean-up to be done by hand labor. Working on such a scheme

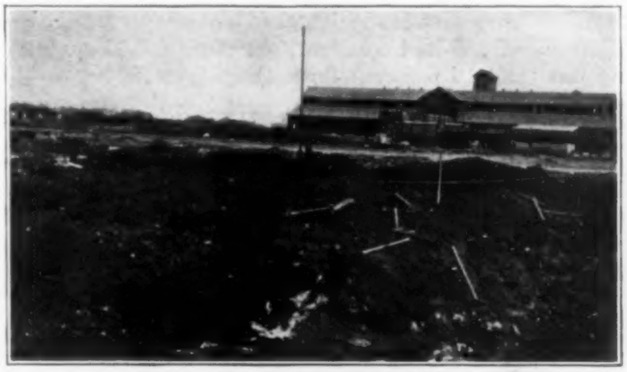


FIG. 6. IRREGULAR SURFACE OF BURNED HEAP

the loss of time and inconvenience of changing buckets would tend to offset the hand digging saved.

A layout which would allow complete clean-up by clam-shell bucket would require a solid floor traversed by depressed air conduits and covered by a layer of refractory ore. Such a floor must resist the extremely high temperature generated during the sintering operation, and still be tough enough to resist the impact of a heavy bucket. A cyclopean sheet cast in large blocks each containing several tons of slowly cooled slag would most likely answer the requirements, but large quantities of molten slag are not obtainable at most zinc smelters. Slag brick, on the other hand, are notoriously unsatisfactory. Extra large vitrified paving block, well cemented, might serve, but would make a very expensive foundation. Any such scheme would further involve a plant cost which is entirely lacking and is the most attractive feature of the present installation, and would probably more than absorb the present labor costs in maintenance and capital charges. Should the present crane be crowded with work to a point where it could not load the rehandled clinker without overtime, a portable conveyor loader would be the logical machine to take the lumps direct from the pile into a gondola.

The sintering plant at Bartlesville comprises a long

row of 17 such "kilns," and ships from 40 to 45 carloads of blast-furnace material monthly—approximately 2100 tons. The daily cost of operation is approximately as follows:

Labor:		
Day foreman and engineer	$4.00	
Night engineer	3.50	
Powderman	3.50	
2 Trammers	6.00	
6 Spreaders	18.00	
7 Diggers	21.00	
2 Men on air channels	6.00	
Total labor		$62.00
Crane:		
Engineer	$6.75	
Fireman	3.25	
Helper	3.00	
Upkeep of crane	25.00	
Cost of crane per day	$38.00	
Crane is busy 33 per cent of its time on this work		13.00
Power		6.00
Switching ashes		10.00
Powder, small tools and miscellaneous supplies		6.00
Superintendence and general charges		10.00
Total daily cost		$107.00

This figures to $1.53 per ton of clinker produced, and in any case should be less than the saving in freight on clinker as compared with crude residue between zinc plant and lead smelter, plus the cost of sintering green residue in a mechanical roaster at the latter place. An additional tangible advantage whose monetary value is difficult to assess lies in the fact that the clinker thus produced is a much more desirable blast-furnace charge from the physical standpoint than ordinary calcine, being quite strong and coherent, yet porous, and containing less than 15 per cent fines (Fig. 7).

General Considerations

Many different kinds of residues have been satisfactorily sintered at the Bartlesville plant in this manner. Apparently lead cannot be too low to prevent clinkering, since in any residue yet tried at this plant there is enough iron and lime either in the original ore or in the fuel ash to properly bind the mass together.

FIG. 7. PILE OF CLINKER READY FOR SHIPMENT TO BLAST-FURNACE

Indeed, a residue containing 10 per cent lead or more is very difficult to sinter, since it melts so easily, becoming viscid, compacting together and obstructing the air blast.

It has been found that a large volume of low-pressure blast is much better than a smaller quantity of air at high pressure. The latter gives a glassy non-porous clinker, through which the air breaks into blowholes or intensely heated craters from which high losses in lead and silver occur. The pile is unevenly burned, poorly agglomerated and high in carbon. For blast purposes we use a No. 10 Sturtevant blower, belt-connected to a 50-hp. gas engine, discharging into a long air main tapering from 30 in. to 18 in. at the extreme end. It has also been found that the distance center to center of air channels has an important effect upon the resulting coke—if they are much beyond 4 ft. apart the material at the bottom of the piles is not coherent, while deep troughs often have to be dug in unburned material above these regions toward the end of the burning stage.

Bartlesville Zinc Co.,
Bartlesville, Okla.

Removal of Limitations on Export of Silver

On Aug. 15, 1918, the Federal Reserve Board announced that licenses for the export of silver would thereafter be granted only for civil or military purposes of importance in connection with the prosecution of the war and only in cases where the exporter certified that the silver to be exported had been purchased at a price which did not directly or indirectly exceed $1.01½ per oz. one thousand fine at the point where silver is refined in the case of silver refined in the United States or at the point of importation in the case of imported silver.

The occasion which required the above limitations on the export of silver having now passed, the Federal Reserve Board will hereafter, unless a governmental necessity should again arise, resume its former policy of granting freely and without condition all applications for the export of silver bullion or of silver coin of foreign mintage.

This change of the policy of granting licenses does not do away with the necessity of filing an application for licenses to export silver bullion or silver coin of foreign mintage. Such applications must, as heretofore, be filed through the Federal Reserve Bank of the appropriate district, but such applications will, as stated above, be freely granted by the Federal Reserve Board.

The Secretary of the Treasury does not contemplate any further sales of silver under the Pittman act, except to the Director of the Mint.

Research Fellowships at University of Idaho

In co-operation with the United States Bureau of Mines and the Idaho Bureau of Mines and Geology, the University of Idaho offers in the School of Mines a number of fellowships. These fellowships are open to college graduates who have had good training in mining, metallurgy or chemistry and who are qualified to undertake research work. The income of each fellowship is $720 a year for the twelve months beginning July 1, 1919.

For 1919-20 the following subjects are being considered:

(1) Flotation—with especial reference to differential separation of various minerals.
(2) Availability of Western wood oils for flotation purposes.
(3) Treatment of the complex gold-silver ores of southern Idaho.
(4) Ore dressing problems.
(5) Mining problems.

Applications, with certified copy of collegiate record, statement of professional experience, and names and addresses of three references, will be received up to June 1, 1919. The applications should be addressed to the Dean, School of Mines, Moscow, Idaho.

Americanization Work by the Colorado Fuel & Iron Co.

THE TRANSFORMATION of an alien immigrant into a useful American citizen is not completed when he has been taught to speak the English language. Recent events give ample evidence that some of the men who speak English most fluently—and most volubly—in public and in private are about the worst of Americans. On the other hand, ample proof of patriotism has been given time and again by foreign workmen whose knowledge of English is extremely limited. No one should attempt to belittle the importance of instruction in the English language. There is danger, however, that some will consider this instruction the chief end and aim in the Americanization of our alien workmen.

The Colorado Fuel & Iron Co. has about 12,000 employees, of whom the majority are of foreign birth or parentage. In 1916, after a survey of the company's steel works and mining camps by Dr. Peter Roberts, Immigration Secretary of the International Y. M. C. A. Committee, instruction in English was begun for the benefit of those workmen unfamiliar with the language of their adopted country. This instruction has since been carried on principally by the Y. M. C. A. secretaries who are in charge of the clubhouses at the various properties of the company. The instructors have proven energetic and efficient, and good progress has been made by pupils of various ages and different nationalities.

After the entrance of the United States into the war the company and the Y. M. C. A. received the hearty cooperation and assistance of Mr. J. C. Stephens, Director of the Committee on Americanization, Colorado State Council of Defense. Under his guidance it is expected that progress in the teaching of English and in preparing foreign workmen for citizenship will be even more rapid than before. In its endeavors to make good American citizens out of its alien workmen, however, the Colorado Fuel & Iron Co. has laid principal stress upon factors which it believes to be even more fundamental than instruction in English. The Italian, Greek or Slav, transplanted into a mining camp or a steel plant, if left to himself, is tolerably certain to acquire a smattering of English. What is less certain, however, is that he will at the same time learn American principles of government and American standards of living. The proverbial—and generally mythical—miner who stores coal in his bathtub is in need of something more than instruction in the English language. It is necessary that he be taught the principles of our system of government and what it stands for.

PATRIOTIC PARADE OF COLORADO FUEL & IRON CO. MINERS

The Colorado Fuel & Iron Co. is endeavoring to meet the needs of education in American ideas of government and standards of living through a careful fostering of community spirit and through a program of social and industrial betterment. This work is founded upon the Industrial Representation Plan—the so-called Rockefeller Plan—under which all employees deal with the company through representatives elected from among their own number. Through the constant application of industrial democracy, it is believed that sound principles of political democracy will be engendered.

DOMESTIC SCIENCE CLASS IN PUBLIC SCHOOL IN A COLORADO FUEL & IRON CO. CAMP

By means of the activities of the Y. M. C. A. and the social and industrial betterment work carried on by the company, different races and nationalities are brought into social intercourse and fellowship. This has been found beneficial to the workmen and the employer and doubtless tends to increase loyalty to American institutions. High wages, modern housing and the teaching of housekeeping have gone far toward establishing American standards of living. In the public schools in the various communities the children of employees of all nationalities are brought into contact with the English language and American ideals. At one of the schools a number of years ago a plan was inaugurated of giving the children credit for the work they did at home in teaching their parents the English language and subjects relating to American citizenship.

Since the United States entered the war against Germany, patriotism has been taught forcibly and directly to the employees. Encouragement has been given to enlistment in the Army and Navy and to contribution to the various loans and war funds. The result of this encouragement has been exceedingly gratifying and leads officers of the company to believe that the lessons in citizenship taught in the past have borne abundant fruit.

Metallic Coatings for Rust-Proofing Iron and Steel—II

Metallography of Zinc Coating—Variation in Structure of Hot-Dipped, Sherardized, Sprayed and Plated Galvanized Products—Significance of Structures—Methods of Preparing Surfaces for Coating and Their Effects Upon the Mechanical Properties of Steel—Bibliography

By HENRY S. RAWDON[1], M. A. GROSSMAN[2] AND A. N. FINN[3]

Most of the metals used for covering iron and steel as a preventive of corrosion form coatings which are very simple in structure. The metal alloys with the iron of the base to such a slight extent that no change in the microstructure of the resulting coating can be detected, and, in all probability, the behavior of the coating in resisting corrosion is not affected to an appreciable extent. With zinc, however, the case is quite different (15, 16, 18, 21, 23)—particularly is this so in the coatings which are by the application of heat. The zinc alloys with the iron to such a degree that the coating is relatively complex in structure and the properties of such coatings are very appreciably affected. In some coatings (52) certain of the microstructural constituents present may actually accelerate the attack of the metal which the coating is aimed to protect, and the technical literature contains various misleading statements (21) which if correct would suggest that a similar condition may exist in certain classes of zinc coatings.

Theoretical Microstructure of Zinc Coatings

In at least two of the four types, the coating is far from being a simple layer of zinc superimposed upon the base metal beneath, but is a rather complex one, composed of alloys of iron and zinc of various compositions. In order to understand properly the formation of these alloys and their composition, and for purpose of reference, the constitutional diagram of the iron-zinc alloys as modified by Raydt and Tammann (17) is included herewith.

Alloys with an iron content of more than 25 atomic per cent (22 per cent by weight) are formed only with difficulty, usually by melting the constituents under pressure; hence, a structure corresponding to an iron content beyond this point may be disregarded in the discussion of zinc coatings. The constitutional diagram shows four structural fields or layers which are possible in a coating which is allowed to come to equilibrium with the iron base. These are, (1) an outer one (m) of zinc containing a small percentage of iron in solid solution (about 0.7 per cent); (2) a duplex one (m . . . n) composed of a matrix similar to 1 in which are embedded particles of n (a solid solution of a chemical compound $FeZn_7$ with some zinc); (3) a layer composed entirely of the solid solution n, and (4) a duplex layer of two definite chemical compounds $FeZn_7$ and $FeZn_3$—the amount of each compound varies in this field from pure $FeZn_7$ on one side to $FeZn_3$ on the other.

The variations in structure corresponding to the different fields of the structural diagram are illustrated in Fig. 2, which shows portions of the coating produced on an iron wire (16 B. & S. gage) embedded in a block of zinc about ⅜ in. (1 cm.) square in section by heating for 4 hours slightly above the melting point of zinc (approx. 450 deg. C.). Iron from the wire permeated throughout the zinc block so the resulting coating includes practically the entire block.

Adjacent to the iron is a thin layer, B, of intermetallic compound $FeZn_3$; just outside of this, a much thicker layer, B', in which the definite form of the crystals is plainly seen (this probably contains both $FeZn_3$ and $FeZn_7$); a very thick layer, C, consisting of tiny crystals of the compound $FeZn_7$ in a softer matrix comprises by far the greater part of the coating; the crystals in the outer margin of this layer are particularly well formed and much larger than the average throughout the layer. The outermost portion, D, of the coating shows the characteristic etch-markings of "pure" zinc; these are probably of the nature of Neumann lines; the metal here shows only a few traces of the second constituents; it undoubtedly contains iron, in solid solution, up to its saturation point (0.7 per cent). The nature of the various layers and their behavior during corrosion is discussed below.

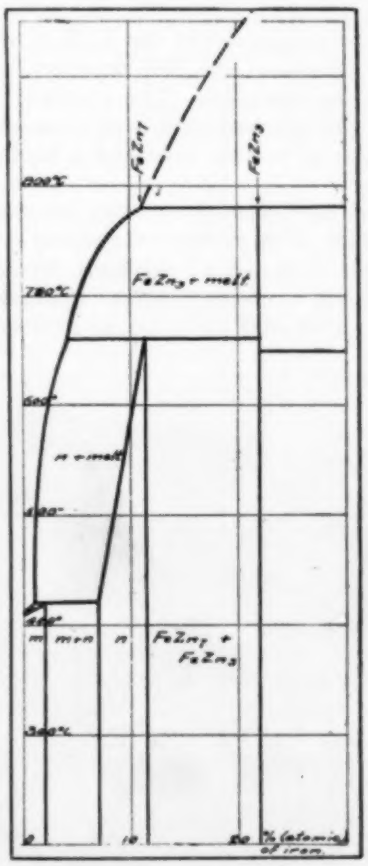


FIG. 1. PORTION OF THE CONSTITUTIONAL DIAGRAM OF THE ZINC-IRON ALLOYS

Variations in Microstructure of Commercial Coatings

a. Hot-Dipped Materials. The variations in structure of this type of coating which may arise in practice are best shown by comparison with the structure when equilibrium is reached, as described above. In general, the same layers are formed in each specimen of this type; the relative amount of each constituent, however, varies considerably according to the conditions of dipping. Fig. 3a shows the structure of a thin coating of this type (galvanized sheet, described by manufacturers as having 1.37 oz. of zinc per sq.ft., i.e., 0.68 oz.

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[3]Associate Chemist, Bureau of Standards.

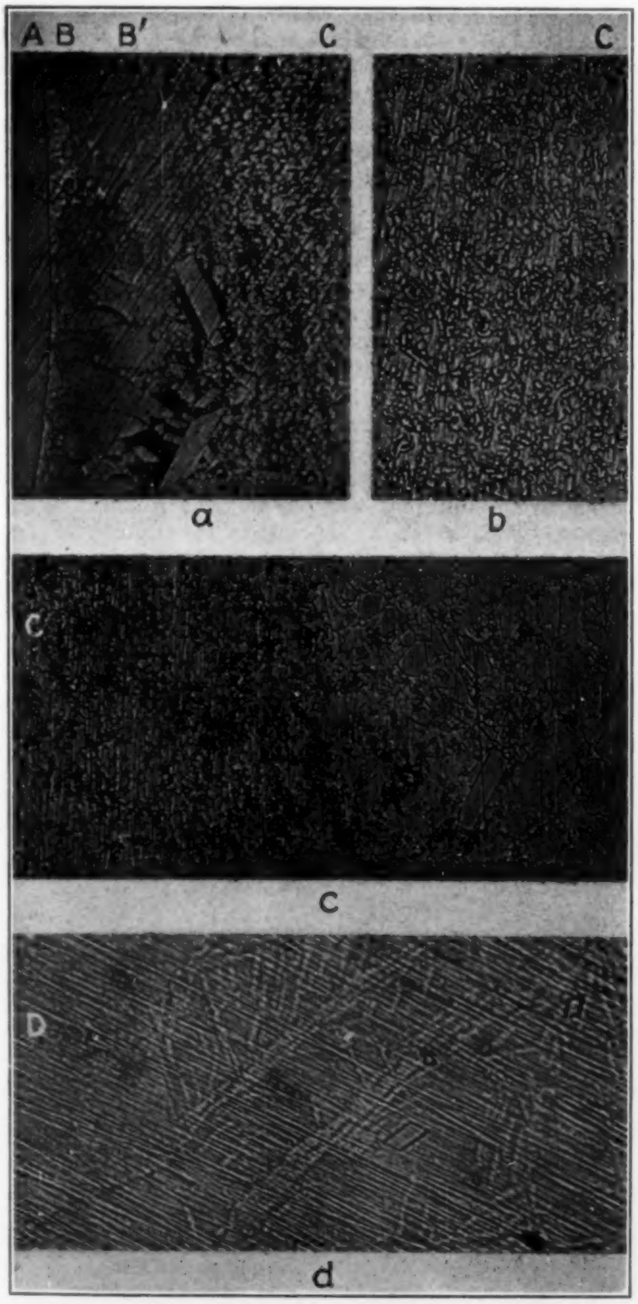

FIG. 2. MICROSTRUCTURE OF ZINC COATING FORMED ON AN IRON WIRE IMMERSED IN MOLTEN ZINC FOR FOUR HOURS

a: A. Iron wire. *B.* Alloy layer, $FeZn_3$, adjacent to the steel base. *B*[1]. Layer of the compound $FeZn_7$ (with perhaps some $FeZn_3$). *C.* Duplex layer of crystals of $FeZn_7$ embedded in a softer matrix of zinc containing some iron in solution. × 500. *b:* Intermediate portion of layer *C.* × 500. *c:* Outer portion of layer *C:* the crystals of $FeZn_7$ in the outer portion are large and well formed. × 200. *d:* Outer layer of zinc (containing some iron in solution). The shadow-like etch markings are rather characteristics of zinc. × 200. Etching: 1 per cent. iodine in alcohol was used throughout and for the remaining samples unless stated otherwise.

per sq.ft. on each side). A very thin innermost layer of $FeZn_3$ is to be seen of approximately the same thickness as in the heavy coating (Fig. 3b), which contains 2.5 oz. of zinc per sq.ft. (1.25 oz. per sq.ft. each side). Inasmuch as the thickness of the commercial coating is ordinarily controlled by mechanically adjusting the height of the molten bath relative to the guiding rollers and not by increasing the period of immersion in the zinc, it is to be expected that such would be the case. Fig. 4 shows this innermost layer in a very oblique section of a coating. By holding the article to be coated for a much longer period in the molten zinc, this layer is given a chance to increase considerably in thickness, as is shown in Figs. 5a and 5b, which represents a sample held for approximately eight times as long in the bath as is considered good commercial practice, and a sample which was run through the bath several times in succession.

The intermediate alloy layer appears to be of approximately the same thickness in both the thinly and thickly coated commercial sheets, the difference in the weight of the coating being due to an increase of the outer zinc-rich layers in the thicker coating. (The removal of the excess outer zinc-rich layer in the thin coatings does not allow the crystals of the intermediate alloy layer to form as perfectly as is the case in the thick coatings.) By lengthening the time the molten zinc is in contact with the iron base the relative thickness of the alloy layers is increased—this will be accompanied by a corresponding decrease in the outer zinc-rich layers, particularly in the coatings of sheets and wires, in which the thickness is kept fairly uniform by some mechanical means. The

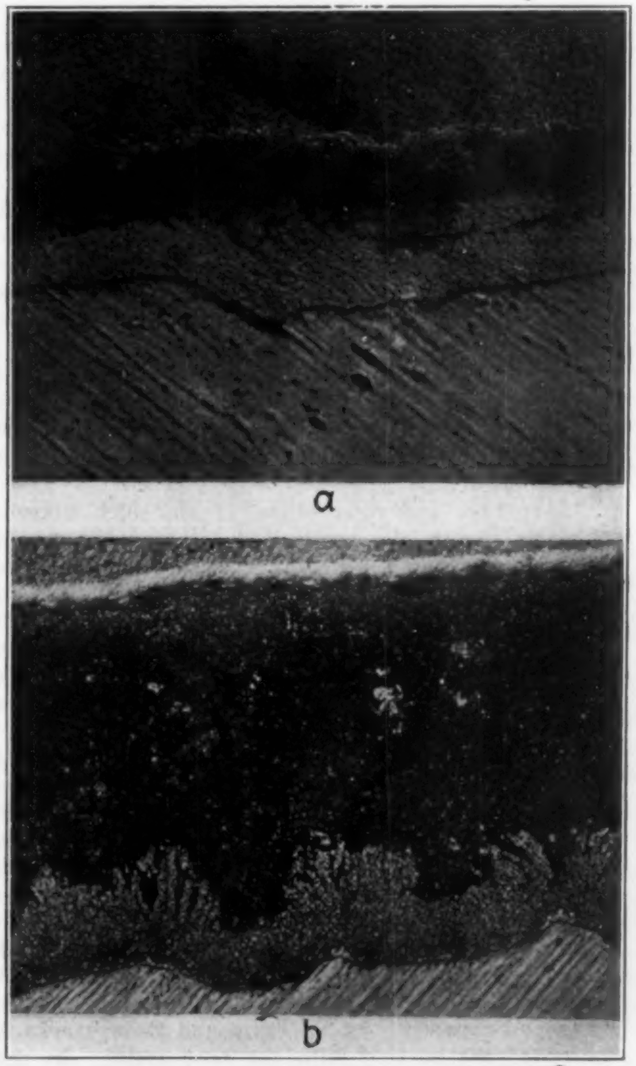

FIG. 3. COMMERCIAL HOT-DIPPED ZINC COATED SHEETS

a: Thin coating; average weight of coating as determined by weighing the sheet before and after dipping 1.37 oz. per sq.ft. *b:* Thick coating; average weight, 2.5 oz. per sq.ft. × 500. All micrographs are arranged (here and following figures) so that the alloy, or inner, layer is toward the bottom of the page.

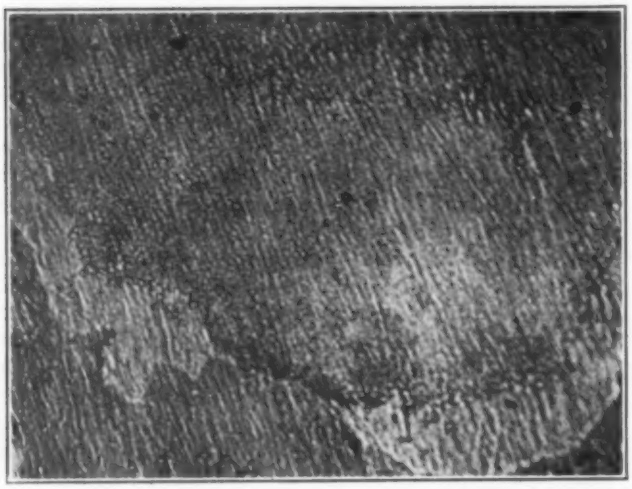

FIG. 4. COMMERCIAL HOT-DIPPED ZINC COATED SHEETS
Oblique section of material of *b*, Fig. 3, showing the inner layers of $FeZn_3$ (white). × 500.

significance of these alloy layers in service is indicated later in this article. The sheets which were held for a considerable length of time in the molten zinc were found, after standing about two weeks, to be spotted with numerous exudations (Fig. 6b). There is nothing in the microstructure to account for this other than some tiny pockets which were apparently filled with inclusions of the zinc and ammonium chloride flux from the bath and which, under the influence of atmospheric moisture, swelled and exuded out of the coatings.

Whether such inclusions of the flux will materially affect the life in service of such coated sheets cannot be stated with certainty from a study of the structure alone. Most of the pits and inclusions, however, appear to be in the outer layers of the coating, and not between the base metal and the coating.

b. Sherardized Coatings. In coatings of this type it is only in those of considerable thickness that any definiteness of structure appears. Figs. 7 and 8 show the structural features which may be expected to occur in coatings of this type.

The nature and composition of zinc-dust mixtures in which the articles are packed for heating probably determines almost entirely the nature of the outer layer; in the innermost layers alloying with the iron base occurs. The outer portions have a characteristic rough and porous appearance and contain a considerable number of inclusions of oxide and any foreign ingredients which may be present in the heating mixture.

The inner portion of this outer layer is much denser than that near the outer surface and has a very characteristic appearance, being broken up by many fine intersecting cracks, caused probably by contraction upon cooling. The layer probably contains a considerable amount of the compound $FeZn_7$. The intermediate layer (Fig. 8b), which easily etches dark, in all probability marks the outer limit of the pronounced alloying of the iron of the base with the zinc of the coating. An extremely thin layer immediately adjacent to the iron base, and apparently of the compound $FeZn_3$ marks the union of the coating with the base metal. In none except very thick ones, e.g., 0.008 in., are these two innermost layers usually found; when much thinner, e.g., 0.002 in. or 0.0015 in., the coating consists entirely of what, in the thicker ones, constitutes the outer layer.

c. Sprayed Coatings (12,13). The variations noted in this type of coatings are of a mechanical origin, due to the nature of the method of deposition, rather than to any alloying of the zinc with the iron base. In Fig. 9 are shown cross-sections of two sheets coated by this process. The coating designated as "one spray" is very irregular and extremely thin in spots. The second sample was described by the manufacturers as a "four spray" coat, but the structure suggests that a coating somewhat heavier than this was applied. The distinct lamellæ which comprise the coat are due to the additional layers of zinc superimposed upon the earlier ones, with some accompanying oxide. Similar features are shown by "sprayed" coatings of other metals.

d. Plated Zinc Coatings. As is to be expected from the nature of the process by which such coatings are deposited, they are essentially of pure zinc and show none of the different alloy layers seen in the first two types. Fig. 10 shows a coating of electrolytic zinc, deeply etched. No indications of structural variations across the section of the layer are to be seen.

The principal point of interest in connection with the microstructure of this type is the variation in

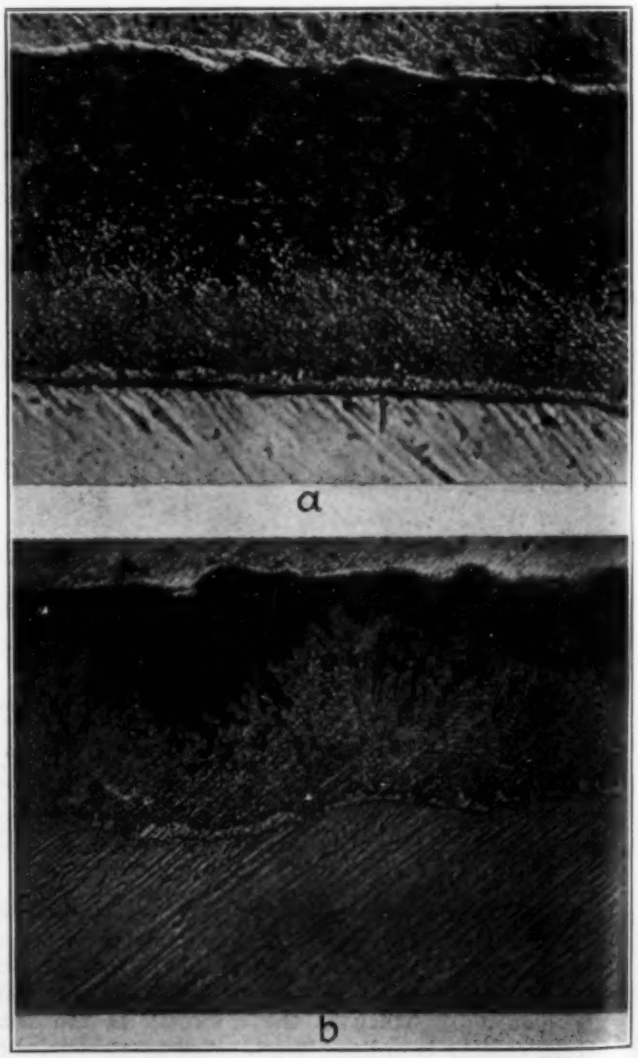

FIG. 5. COMMERCIAL HOT-DIPPED ZINC COATED SHEETS
These were produced under unusual conditions. *a:* Material similar to that of Fig. 3 which was held stationary in the molten bath for two minutes. *b:* Material similar to *a* re-run through the molten bath four times. The alloy layers have been much accentuated by these treatments. × 500.

thickness which may exist on irregularly shaped pieces or even on flat surfaces. Such variations are to be found, particularly in depressions, and on sharp projections where the differences in the current density are considerable. This is especially true for the threaded portion of bolts and screws.

A set of measurements on two similar small machine bolts plated under identical conditions for different periods of time gave the following results:

Weight of Coating Computed From Tank Conditions	Average Thickness, Top of Thread	Average Thickness at Root of Thread
0.20 oz./sq.ft.	0.0157 mm.	0.0038 mm.
0.55 oz./sq.ft.	0.0224 mm.	0.0053 n.m.

Fig. 11 shows the variation in thickness of coating on a small article having several sharp corners. The rivet is shown natural size; the thickness of the coating has been magnified approximately 200 times.

Even on flat surfaces the coating is not of uniform thickness. Fig. 12 shows a series of thickness measurements made on sections of a plate 4 in. square, which had been electroplated under very carefully controlled commercial conditions. The sections were cut ½ in. apart, the longer one being taken along a diagonal of the plate. The plate is shown natural size, the relative thickness of the coating has been magnified as indicated. The features described above for electrolytic zinc coatings may be taken as typical of coatings of other metals electrolytically deposited. The microstructure of electrodeposited coatings depends almost entirely upon the conditions of plating, composition and concentration of solutions, etc. (14, 19). Fig. 13 may be considered typical of a normal deposit of electrolytic copper from the commonly used acid-sulphate bath. The variations in thickness of such coatings in very deep, sharp grooves is shown in Fig. 13b. Fig. 14 shows the structure of the copper-clad steel described in the first section of this article.[1] A very thin but definite intermediate alloy layer has formed between the two metals.

FIG. 7. STRUCTURE OF SHERARDIZED COATINGS

Oblique section of a coating averaging 0.008 in. in thickness. × 100. *A:* Decarburized surface of the steel plate. *B:* Inner layer of coating. (Probably contains $FeZn_3$.) *C:* Intermediate fissured layer of the coating. ($FeZn_7$?) *D:* Roughened outer surface.

FIG. 6. SURFACE APPEARANCE OF HOT-DIPPED SHEETS

a: Usual appearance. *b:* Appearance of the material of Fig. 5. Upon standing the surface became covered with spots of flux which exuded from within the coating. Natural size.

SIGNIFICANCE OF STRUCTURE OF COATINGS

Metallic coatings may protect the metal which they cover in different ways; all coatings afford a mechanical protection against moisture and other corroding agencies. Some metal coatings also by their greater solubility than the base metal protect the metal beneath from corrosion in a chemical way. As previously stated, of the common metals used for coatings, zinc is the only one which behaves in this manner. The significance of the various structures which may occur in different types of coatings should be considered with reference to the bearing they may have upon these two functions which the coating has to perform.

[1]CHEM. & MET. ENG., Vol. 20, No. 9, p. 460.

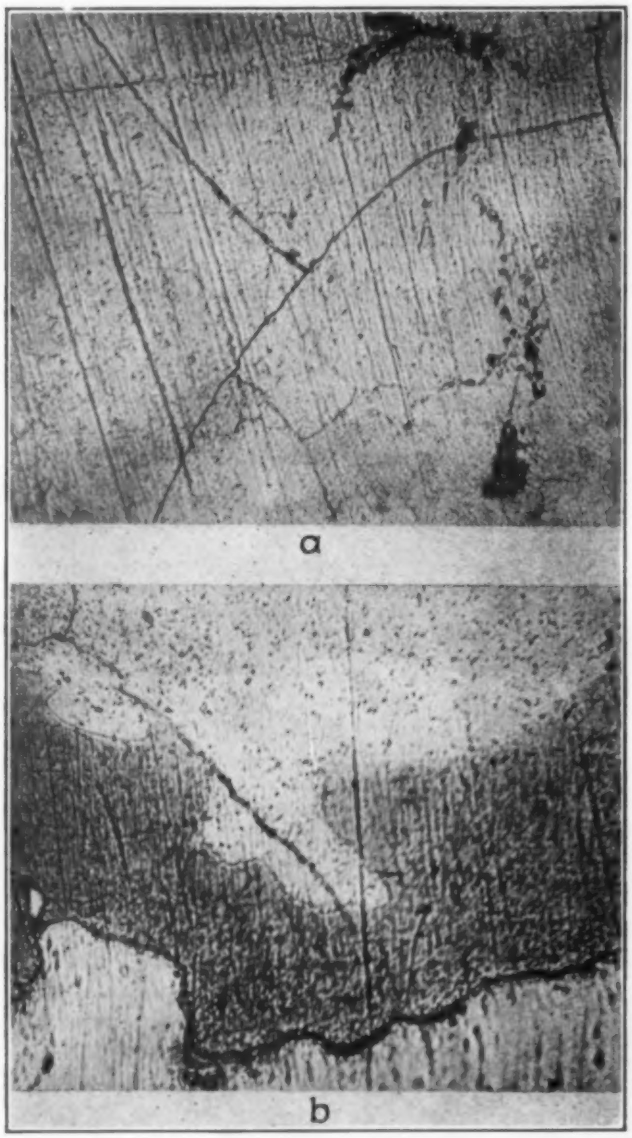

FIG. 8. SHERARDIZED MATERIAL

a: Section of intermediate layer, showing the network of fine cracks and some of the inclusions retained from the heating mixture. *b:* Inner layer, which probably represents the extent of the pronounced outward alloying action of the iron—a very thin film of the compound, presumably FeZn, lies immediately adjacent to the iron base. × 500.

Various conflicting statements have appeared in the literature concerning the relative electrolytic solution potentials of the different zinc-iron alloys, particularly those which occur in galvanized coatings. The behavior of the alloy layers upon etching indicates that they are electro-negative toward the zinc, i.e., they bear the same general relation to zinc in this respect that iron does. Further than this cannot be stated with certainty from an examination of the microstructure above. Guertler (21) states that the innermost layer ($FeZn_3$) is also more electro-negative to the zinc than is iron, and hence iron will be electro-positive to such a layer; so that when both are exposed to the corroding influences, by the wearing away of the outer layers by mechanical injury, etc., corrosion of the iron will be accelerated by the inner layers. Others have apparently reiterated Guertler's statement, though some have later corrected such statements. The diagram below is constructed from the e.m.f. measurements of the system $Zn — \frac{N}{20} ZnSO_4 —$ FeZn alloys (20) and shows that all the alloys behave toward iron in the same general manner as does pure zinc, though not to the same degree.

Although both of the compounds, $FeZn_7$ and $FeZn_3$, are electro-negative toward zinc, and so will aid in the solution of the zinc when either one is exposed to the corroding agency along with the zinc, it appears that such action is not serious and may safely be disregarded. Fig. 16 shows a section of the coating on hot-dipped galvanized sheet on the exposed and unexposed sides after more than 30 years of service.

The intermediate alloy layer in this material was remarkably well developed—the section of the exposed surface shows that the coating has been quite uniformly corroded away and at the point where the section was taken the inner strata of the alloy layer still remained intact. The claim has been made that zinc coatings containing as large a percentage of the alloy layer as consistent with the mechanical properties desired (freedom from flaking on bending, etc.) are very desirable (35). On account of the lower potential difference between iron and the zinc-iron alloys as compared with that between iron and the pure zinc, those coatings containing the excess of the alloys might be expected to have the longer life in service. Such coatings will, however, not be able to exert protective influence over as large bare spots as will those of much purer zinc.

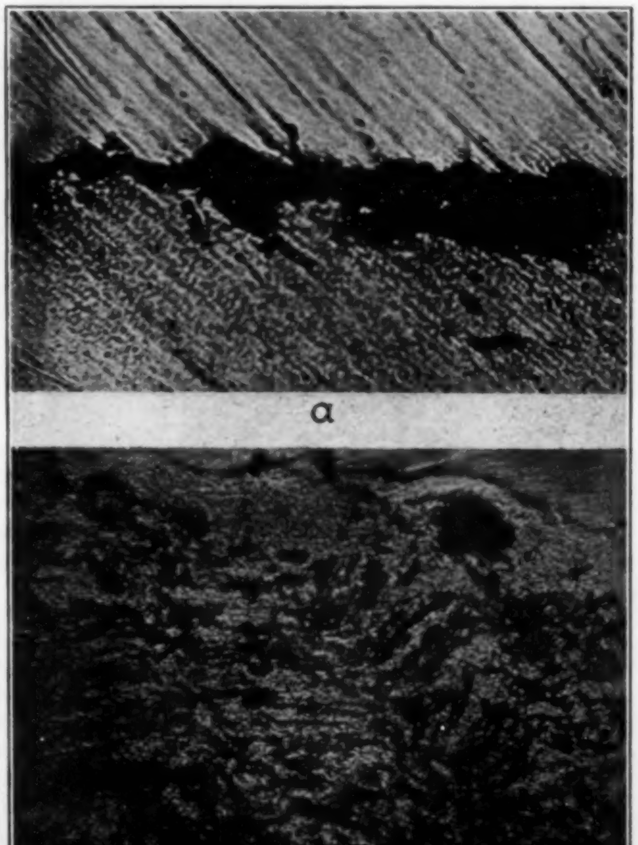

FIG. 9. CROSS-SECTION OF "SPRAYED" ZINC COATING

a: "One spray" coat. *b:* "Four spray" coat. × 500.

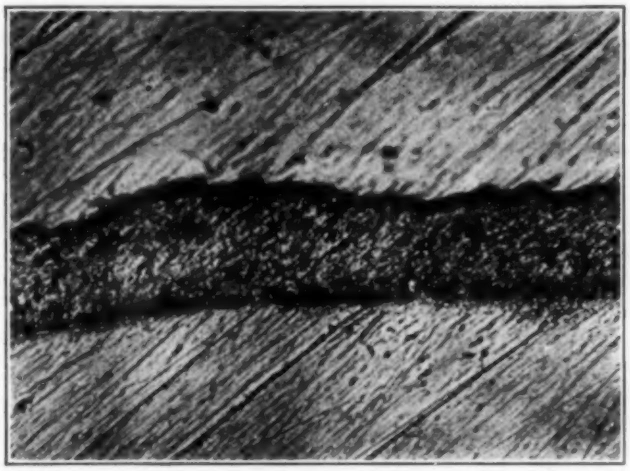

FIG. 10. CROSS-SECTION OF ELECTROLYTIC ZINC COATING, DEEPLY ETCHED WITH 10 PER CENT SODIUM HYDROXIDE. × 500

Inasmuch as these alloy layers are never found in two of the other types, the sprayed and the electrodeposited, the resistance to corrosion of articles covered with such coatings depends entirely upon the thickness of such coatings and on the uniformity of the coating. The variations which may be expected in this feature of these two types of coatings have been discussed above.

Like most intermetallic compounds, the layers of $FeZn_7$ and $FeZn_3$ are relatively hard and brittle. The compound $FeZn_3$ appears to be considerably harder than is the other compound, so that coatings in which it is well developed are easily separated from the base metal, by sharp bending. The fine crystalline condition of the electrolytic and the sprayed coatings probably exerts

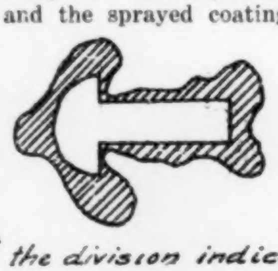

FIG. 11. VARIATION IN THICKNESS OF THE ZINC COATING (ELECTROLYTIC) ON AN OBJECT HAVING SHARP ANGLES

as great an influence as does the absence of any brittle layers in such coatings in preventing them from stripping loose from the base metal as is the case in thick coatings of the hot-dipped type.

Preparation of the Surface Before Coating and Accompanying Effects Upon the Mechanical Properties of Steel

The successful application of coatings to steel requires that the surface of the specimen shall be clean, i.e., free from all oxide and non-metallic material. The general methods of cleaning are: the chemical (63, 64), in which the scale is removed by a direct chemical process of solution; the electrolytic (62, 66), in which the material is made anode or cathode in an electrolytic bath; and the mechanical, in which the scale is removed by abrasion, such as sand blast, tumbling, etc.

The most widely used cleaning process is a chemical one—it is the process of "pickling" in sulphuric acid. It has the advantages of being rapid and inexpensive, of reaching all parts of irregular specimens and of being readily handled by inexperienced operators. In general, the samples are immersed for from 5 to 30 minutes in sulphuric acid of concentration 2 to 15 per cent by weight and at temperatures from 25 to 60 deg. C. Other reagents for pickling include hydrochloric acid, hydrofluoric acid (which is especially useful for cleaning sand castings) and solutions of sodium acid sulphate.

The chief disadvantages of pickling processes are (1) that when the thickness of the scale is not uniform over a specimen, the steel at cleaned portions remains exposed to the action of the acid until the last of the scale is removed from other portions (65), and (2) that there is a skin effect, causing brittleness, which becomes quite pronounced on thin specimens. This brittleness is generally presumed to be due to surface absorption of hydrogen (60, 61).

Experiments have been conducted at the Bureau with

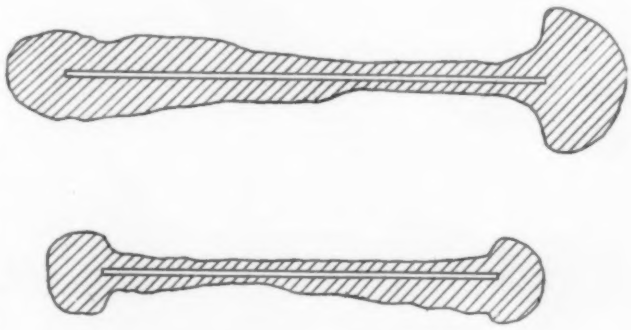

FIG. 12. VARIATION IN THICKNESS OF THE ZINC COATING (ELECTROLYTIC) WHICH MAY OCCUR ON FLAT SHEETS

a view to determining the conditions in the pickling operation that tend to increase brittleness. In a preliminary series of tests on $\frac{3}{16}$-in. wires, specimens variously treated were tested in tension, and the change in percentage elongation taken as a measure of the embrittling effect. The results of these tests seem to indicate that the temperature of the pickling bath has but little influence. Increase of the concentration of the acid increases the brittleness, as does also a longer

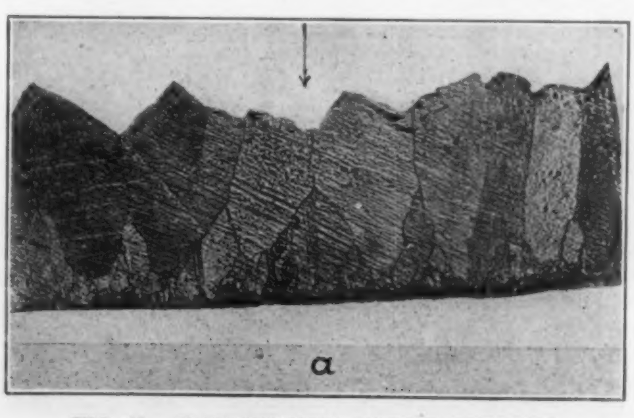

FIG. 13. ELECTROLYTIC COPPER DEPOSITS

a: Cross-section of a deposit on a flat surface, plated from a sulphuric acid-copper sulphate bath with relatively low current density.

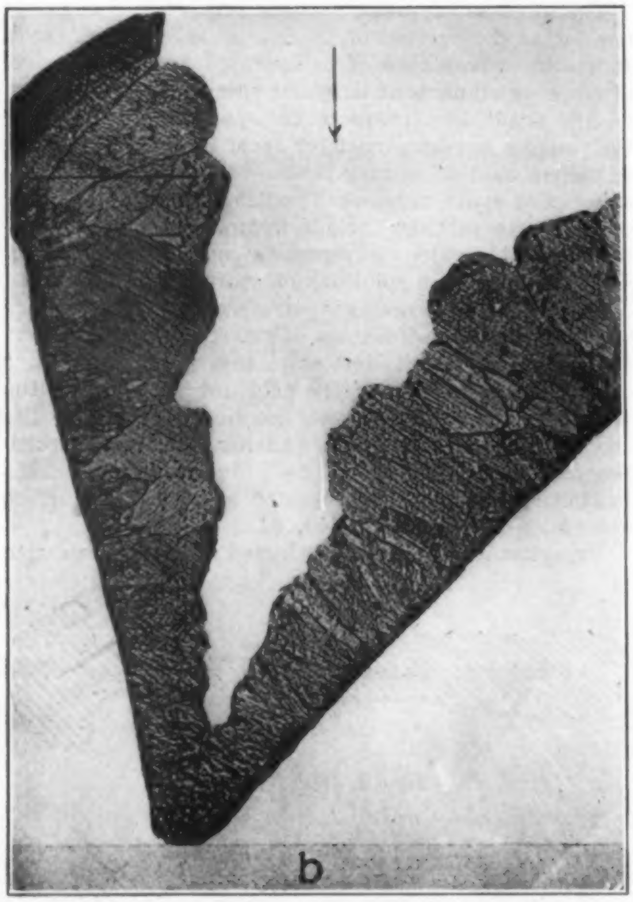

FIG. 13B. ELECTROLYTIC COPPER DEPOSIT

b: Same type of deposit as in Fig. 13 within a narrow V-groove. The arrow indicates the side from which the metal was deposited. × 500. Etching concentrated ammonium hydroxide and hydrogen peroxide.

immersion period. Heating the samples as in sherardizing (375 deg. C. for 4 hours) removes the embrittling effect. Heating as in hot galvanizing (450 deg. C. for 2 minutes, though 2 minutes is considerably longer than the average practice) partially removes the brittleness. It has been stated that heating at 225 deg. C. for 6 hours removes the embrittling effect altogether. Further experiments are in progress at the Bureau, in which wires are being treated by various methods and then tested in impact and alternating stress.

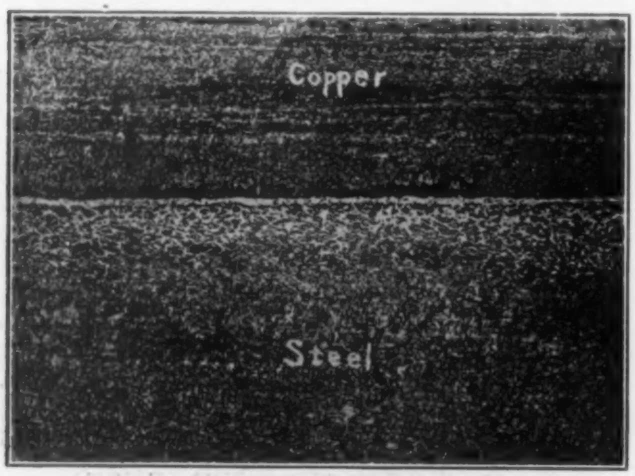

FIG. 14. COPPER-CLAD STEEL

A definite alloy layer has formed between the two metals. × 500. Etched with concentrated ammonium hydroxide followed by a 2 per cent nitric acid.

In the electrolytic method of pickling (62, 66), the sample is placed as cathode or anode in an electrolyte through which a current is passed. When the steel is the cathode, the hydrogen liberated there reduces some of the oxide scale and also aids mechanically in flaking off much of it; when the steel is the anode, the

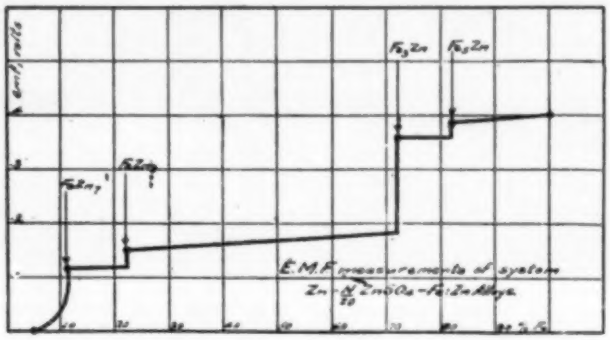

FIG. 15. E.M.F. MEASUREMENTS OF THE SYSTEM $Zn - \frac{N}{20} ZnSO_4 - FeZn$ ALLOYS

oxygen there liberated mechanically detaches the scale, which later may dissolve in the electrolyte. The concentration of hydrogen at the cathode would be expected to cause more brittleness, as compared with the anode, and experiments made elsewhere have shown that samples cleaned at the anode are much less brittle (61).

Of the mechanical methods of cleaning, the sand blast is the one most widely used. The strong stream of sand particles abrades or chips off the particles of scale

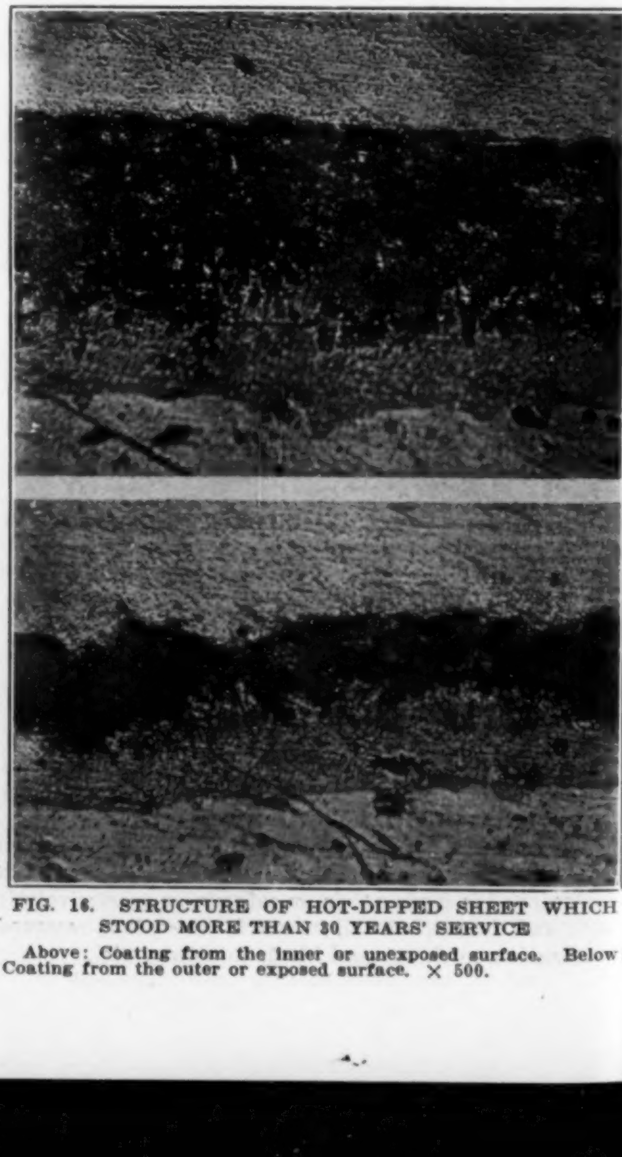

FIG. 16. STRUCTURE OF HOT-DIPPED SHEET WHICH STOOD MORE THAN 30 YEARS' SERVICE

Above: Coating from the inner or unexposed surface. Below: Coating from the outer or exposed surface. × 500.

from the steel. The method gives a smooth, bright surface, but takes more time than pickling and does not satisfactorily reach crevices. Steel shot and crushed steel are said to have some advantages over sand. It must be remembered that the "cold-work" of impact will cause hardening of the surface, which may be quite noticeable on thin sections and sometimes quite harmful.

Another process of mechanical cleaning consists in "tumbling" the specimens in a rotating barrel, with emery and water. It is an abrasion process. A similar method, used on small articles, involves rolling with emery and oil, between rollers. It is the mildest process of mechanical cleaning, and while quite slow it has advantages for springs and the like, in that it avoids both the brittleness from pickling and the hardening from the sand blast.

Hand Device for Flotation Experiments*

By Will H. Coghill
Metallurgist of the Bureau of Mines

In FLOTATION experiments it is desirable to have a hand device correlating successively with the experimental and commercial machines. This phase of flotation has not been sufficiently developed. It is the purpose of this paper to describe a device which is intended to fill this gap.

Success in designing a machine depends upon the principles selected to govern its detail. The principles laid down to guide in the selection of this device are: The pulp density, and the ratio of solids to frothing surface, must be the same as in well designed machines.

The importance of these factors can best be emphasized by quoting from Del Mar.[1]

"Under manipulation may be included the shape or form of the collecting-chamber of the flotation machine, for the cells in any flotation system are used for two purposes, either to float a dirty concentrate, which must be cleaned before marketing, or to float a finished concentrate, which is ready for shipment. In the former case the collecting chamber of the machine should favor a quick discharge, that is, there should be a narrow chamber, but when we require a finished product the box must be sufficiently wide to allow the settlement of occluded waste or gangue. Manufacturers of flotation machines miss this point and therefore the same machine is often used for roughing and for cleaning, while the two operations require entirely different manipulation. This important structural feature in the flotation-chamber may make the difference between success and failure, for not only must a concentrate be produced, but it must attain a certain grade of metallic content to be fit for shipment."

Consistent Proportions

On observing successful laboratory flotation machines of the mechanical agitation type we find that when the pulp density is 3 to 1, there is from 30 to 60 grams of ore for every square inch of frothing surface.

Let us see now if the test tube, which was recommended a long while ago, has proportions that are consistent.

Take a test tube of such a diameter that it gives a frothing area of 0.6 sq.in. The quantity of ore required is then, say, 30 grams, and for a 3 to 1 pulp, 90 cc. of water must be added. But the ordinary test tube of this diameter will hold only 85 cc. of water. It is eight inches long. We see then that after making allowances for the volume of ore and air, the test tube would have to be about a foot long.

It is obvious that the adoption of these proportions in such a device would not be consistent. A loaded bubble which chanced to be at the bottom of the tube at the end of the agitation period would have to travel upward a distance of nearly 12 inches against a falling column of solids before it could deliver its burden to the froth. Needless to say, it would be wrecked at the outset and buried beneath the column of ore.

Moreover, the test tube has no facilities for discharging the froth.[2]

The device which is recommended here has been used at the Northwest station of the U. S. Bureau of Mines at Seattle. It consists of two pyrex flasks, one of 250 cc.

and the other of 500 cc. capacity. A rubber nipple is placed on the neck of the smaller one so that when the flaring portion is ground off it will fit snugly into the larger as shown in the photograph.

To prepare a test, the smaller flask is filled with a mixture of ore and water of the desired consistency and emptied into the larger one, after which about three cc. of water is added. After the desired flotation reagents have been added a stopper is placed in the flask and we are ready to proceed with the test.

The procedure of testing is by means of hand agita-

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[1]Del Mar, Algernon, "Differential Flotation of Lead and Zinc Sulphides." *Min. and Sci. Press*, Vol. 117, Nov. 23, 1918, p. 692.

[2]The separatory funnel which has been recommended by "A Special Correspondent," *Min. and Sci. Press*, July 24, 1915, p. 122, and by Ralston, O. C. and Allen, Glenn L., *Min. and Sci. Press*, Jan. 8, 1916, p. 44, is faulty because the proportions are not good and the froth has to stand until the tailing is removed

tion for, say, five minutes. The stopper is removed, the flasks are united, and, after a brief agitation, placed in the position as shown. The extra three cc. of water referred to elevates the lower level of the froth so that it will overflow into a collecting pan when the larger flask is removed. The agitation may be repeated as often as desired by adding a little extra water each time.

The efficiency of course is low as compared with the mechanical devices, but the relative floatability of minerals and relative effects of flotation reagents may be quickly determined.

There are two reasons why the efficiency is low: first, there is no opportunity for the froth to build up during the agitation period; second, a small quantity of gangue lodges on the bench formed by the union of the inner and outer tubes, and by joining the overflow reduces the grade of the concentrate.

The quantity of modifying reagents must be determined by calibrated devices. Otherwise impressions may be misleading. This is demonstrated by the following example.

When four drops of oil was added from a medicine dropper the pyrite floated so freely that the results were adverse. The dropper was then calibrated and it was found that four pounds of oil per ton of ore had been used. The test was then repeated with one drop of oil and the results were encouraging.

This device, then, has three points of advantage over the test tube: It has convenient discharging facilities, and it provides for desirable pulp densities and a consistent area of frothing surface.

Improved Form of Granular Carbon Resistance Furnace for Fusion Point of Coal Ash and Firebrick

BY C. H. LOVEJOY

A GRANULAR carbon resistance furnace of the type described in Bulletin 129, U. S. Bureau of Mines, "The Fusibility of Coal Ash and the Determination of the Softening Temperature," has been in use for several years at the Pittsburgh Testing Laboratory, Pittsburgh, Pa. In building a new one last summer, several improvements were added, to facilitate operation and the replacement of worn parts. The furnace was built at slight expense from standard fittings, with very little machine shop work necessary.

In the sketch *D*, the base, was made from an old automobile brake drum housing, filled with a mixture, *B*, of broken firebrick and fireclay.

A-A are made in the laboratory from alundum cement, and baked on the hot plate.

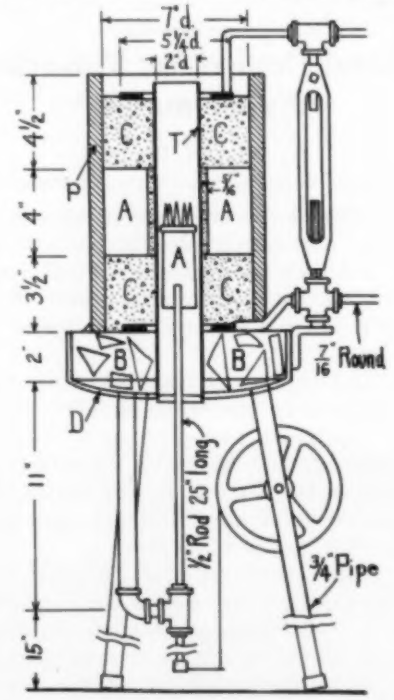
P is a 12-in. length of vitrified clay pipe, with a layer of 20-gage galvanized sheet iron covering the outside.

T, the central tube, is made from 2-in. lengths, $\frac{3}{32}$-in. thick, manufactured by the Norton Co., Worcester, Mass., of No. 288 alundum.

C is granular carbon from the National Carbon Co., Cleveland, O., passing 8 mesh and held on 40 mesh.

The lower wrought iron circular terminal is put in place, the shell *P* set over it, and the lower 3½ in. of carbon poured in. Next the heavy ring, *A*, is placed, the rest of the carbon added, and the top terminal clamped into position. The turnbuckle was intended for bringing the top terminal into close contact with the carbon, but was not found practical, so a set screw was put in the top of the turnbuckle, as shown in the sketch. Of course the terminals are insulated from the iron with hard rubber plugs.

The furnace operates on a 110-volt a.c. line, protected by 100-amp. fuses, and controlled by a 100-amp. 42-point rheostat in series. The furnace is started at about the eighth point, at which the constricted zone should come to a dull red heat in ½ to ¾ hr. Now raise the plunger to the top of the furnace by turning the hand wheel, and place on it the alundum pat which carries the Seger cones together with the test cones made from coal ash and dextrine solution. Lower the plunger very, very slowly, giving the dextrine a chance to burn out. Advance the rheostat two points every five minutes until the coal ashes have fused, and estimate the temperature by comparison with the condition of the Seger cones. The plunger may now be raised and the pat with cones removed for closer observation.



ADVANTAGES OF THIS FURNACE

If this furnace were used for coal ash fusions alone, it would last indefinitely. It is used, however, for fusion points of firebrick up to temperatures of 3000 to 3200 deg. F., at which points the central tube is liable to crack and warp, or the heavy ring, *A*, to fuse. After the furnace has cooled it is a simple matter to remove the rings, beginning at the top, letting the carbon fall through the central tube, and replace the spoiled parts. The carbon in the lower portion lasts indefinitely; that in the constricted zone gradually burns to ash, and should be discarded whenever parts are replaced.

The ease of introducing cones into the furnace and removing for examination, and the possibility of raising or lowering them at any time to the hottest level, has proved to be a great advantage. The increased height of furnace has prevented the iron terminals from becoming too hot, and the solid ring, *A*, stays in place well, yet can be removed when necessary.

Pittsburgh Testing Laboratory.
Pittsburgh, Pa.

Chemical Specifications

BY WALLACE P. COHOE

GENERALLY accepted specifications for the purchase of standard chemicals have been and still are lacking, while the development of chemical trade emphasizes the need of them. If sales of sulphuric acid constitute an index of industrial progress, then trade in other chemicals must augment the sign, for even reference to materials by their chemical names shows a certain understanding of what they are. It is also usually an indication of industrial advancement to find that wares are bought on specification. It shows greater information on the part of the buyer, a larger comprehension of his business; while familiarity with specifications by men engaged in trade may be cited as evidence that they know what they are about.

Of course, contracts for chemicals at the present time are made in accordance with definite specifications, but it does not follow, because Brown purchases from Adams 100 tons of 60 deg. pickling acid, and Jones purchases 100 tons of 60 deg. pickling acid from the same Adams, that both buy according to the same specifications. Probably Brown and Jones are using pickling acid for much the same purpose, but their chemists have slight differences of opinion. In this case, Adams, who sells the acid, will be obliged to make two very slight modifications or to supply the same product to each, trusting that he will not be criticised. Both Brown and Jones will probably be satisfied with what they get, but in order to secure any specification whatever the purchasing agent of each must go to the chemist of each and thus two different specifications are born.

This increasing diversity might continue indefinitely were it not for the fact that large consumers, by their great tonnages, actually do fix a type to which the manufacturer is bound to be held in the main. He cannot make a large variety of products without asking a premium for them. If the purchasing agents of various firms had in their possession standard specifications for pickling acid, to still keep to our example, then the problem as regards both the manufacturer and the customer would be simplified. Trade specifications of standard chemicals do exist. Is there any reason why, in most cases, they should not be generally known?

TRADE SECRETS LEGITIMATE AND HERE TO STAY

Trade secrets are legitimate and there is no use in thinking that specifications will do away with them or that after peace is declared, even though we be destined to live under some new and reformed system of government, we shall know them no more. Trade secrets consist in information that has not become public, and it is not consistent with human nature to reveal that which it is profitable to keep secret. No kind of rule or law can make persons tell everything they know. If anybody doubts this he should visit the library of Cornell University and peruse the torture records which are to be found there.

Trade marks are of value in the case of preparations of secret formula, but in the case of chemicals of known composition the value of a trade mark consists not in putting over something worth a little at a high price upon an unsuspecting or unintelligent buyer, but rather as a mark or guaranty that the goods bearing it shall represent full value.

We are looking forward to big business in chemical industry. There is big business in securities, metals, grain, cotton and all standard merchandise. With the exception of stocks and bonds they are all graded, and daily market quotations giving quantity and price and quality are available. Chemicals are quoted as to value and quantity, but the qualities mentioned in these quotations are vague; they lack the generally recognized standards, such as may be found in regard to cotton, wheat, coffee, etc. We see no immediate need for a Chemical Exchange, but we do see a need for chemical standards. Standardization is necessary before an industry can get into the great brotherhood of trade.

Quality standards are required for a number of purposes. For instance, suppose a shipment of a thousand drums of 76 per cent caustic soda is received and stored. A warehouse receipt is given and a bank lends money on it. Is it electrolytic or made from soda ash, or is it bottoms? The bank does not know, because the warehouse receipt does not tell unless it is accompanied by a satisfactory certificate as to quality. The same holds good as to insurance adjustments. Suppose several carloads of naphthalene are received and made collateral for a loan. Is it prime white, white, or yellow flakes? There may be a difference of 50 per cent in value which the warehouse receipt does not disclose.

AN EXAMPLE FOR ILLUSTRATION

Some time ago a firm bought a considerable quantity of potassium permanganate from a dealer. Examination proved that it contained more Glauber's salt than $KMnO_4$. The dealer from whom they bought it set up the claim that he had purchased it in the market and that in point of fact it was potassium permanganate. It was not guaranteed to be free from impurities, nor was there any specification as to what it might or might not contain. The purchasers were left without recourse. Of course, it may be said that it should have been bought on sample and the sample tested. But this need for checking and counter-checking does not make for good trade practices. There is plenty of work for chemists to do in industry besides unnecessary checking up. The word of a responsible manufacturer should be proof of assay when standards are known.

Specifications are also required to make up a correct balance sheet. It is always good policy to be conservative in the valuation of assets, but it is very bad bookkeeping to record assets as something that they are not. It is nothing less than what Wells calls "economic uncleanness" to make incorrect statements even in the interest of conservatism. Judgment may be availed of in affixing prices, but it has no place in listings.

Buyers used to take what they could get. Commercial oil of vitriol was every color from dark brown through various shades of red and pink to nearly water white. It contained arsenic and lead sulphate and iron, but so long as it was 60 or 66 deg. B., the specifications were fulfilled. Now the specifications as to this chemical alone are so diverse and multitudinous that we shall make it later the subject of a special article. The same holds true of nitric and muriatic acids and of soda.

INDUSTRY MUST KNOW WHAT IT BUYS

Chemical industry must know what it buys. Of course, by going to certain manufacturers a buyer can know what he is getting, but factors of location and market often make such a choice impossible. There are many men of many minds engaged in industry and they display vast differences in their several conceptions of trade ethics. The overzealous salesman also is much

better off if he is held to specifications, even though this at first may almost seem to break his spirit. Granted favorable physical and economic conditions, industry will thrive best wherever technical conditions are best known; and the use of and familiarity with specifications is a function of good technology. Establishments that maintain adequate chemical control do know what they buy, but the lack of known standards among sellers makes this task often difficult and it frequently increases costs far beyond what they should be normally.

The problem of standards in the colloidal field is a difficult one, but it is not beyond the range of possibility. We have, for instance, in this country a great variety of clays available for porcelain and pottery and for coating paper. It may be said without fear of contradiction that there is a disposition among American producers to favor the sale of quantity rather than of quality, and that refined and matured clays might be made available if greater efforts were made to prepare them. The fact that chemical analysis has little value in determining their quality has no bearing upon the subject. Specifications may indicate geologic history and treatment in refining and maturing as well as prohibitions as to the presence of undesired bodies. If such specifications were available, many clays now urgently needed might be obtained from domestic sources. This would be good for our ceramic industries as well as for the paper industry. We do know of one large buyer of clay who has succeeded in so standardizing his physical and chemical tests that he is able to write a specification which will represent the qualities desired.

Demands Will Be Met

Dr. B. C. Hesse investigated on behalf of the U. S. Department of Agriculture the dyes which might be allowed in food products. His work involved not only the study of the constitution of the colors themselves and their effects upon the human system, but also a study of the inorganic impurities which may be present in them, of the chemicals that entered into their manufacture and the possibility of traces of arsenic, copper, lead, etc. This might be called a work of super-refinement or meticulous caution, but it is typical of the scholarship that will insist on having its demands met, either by American or foreign manufacturers.

I have in preparation a book on chemical specifications to be published by the McGraw-Hill Book Co. The task of getting together the material which is now well under way has presented some difficulties, although in the main my inquiries have met with generous responses from manufacturers.

Examples of Trade Specifications

In order to illustrate what I mean, I add a few examples of existing trade specifications, concerned with chemicals mostly below the first rank in importance. These are given as in actual use by reputable firms. They are given also in the hope that they may if possible promote discussion and receive comment to the end that greater enlightenment on the subject may prevail.

Acetic Anhydride:

Commercial form: Colorless liquid.
Boiling point 130 deg. to 140 deg. C.
Contains not less than 60 per cent acetic anhydride and not more than 40 per cent glacial acetic acid.
Contains not more than 0.1 per cent chlorine.
Contains not more than 0.1 per cent sulphur.
Delivered in carboys.

Commercial Acetone:

Colorless liquid.
Consists chiefly of acetone, methyl alcohol and methyl acetate derived from crude wood alcohol.
Contains not less than 55 per cent of true acetone by the Messinger test.
Delivered in steel drums.

Commercial Tannic Acid:

Commercial powder, yellow to brown in color.
Average commercial purity of 80 to 88 per cent.
Clearly soluble in water and 20 per cent acetic acid.
Moisture 12 per cent.
Ash 2 per cent.
Put up in barrels of 350 lb. net.

Ammonium Chloride:

White crystalline solid.
Average commercial purity 99 per cent.
Packed in form of powder, which must be free from grit or other foreign substance.
Must be white or nearly white in color.
Must contain at least 98.1 per cent ammonium chloride on dry basis.
Must not contain more than 1 per cent known volatile impurities.
Moisture, not more than 0.25 per cent.
Pyridine, not more than 0.005 per cent.
Thiocyanates, not more than 0.01 per cent.
Must contain no trace of acidity or of phenols.
Packed 250 lb. to a barrel 19½ x 30 in. with crêpe paper lining.

Carbon Tetrachloride:

Colorless liquid.
Boiling point, 75 to 76 deg. C.
Sp.gr. 1.596 at 15 deg. C.
Average commercial purity, 98.5 per cent.
Allowable impurity not more than 2 per cent. of CS_2.
Packed in 55 or 110 gal. drums.
Extra for packing and shipping in carboys or bottles.

Naphthalene:

White crystalline solid.
Melting point, 79 to 80 deg. C.
Boiling point, 218 deg. C.
Should boil off within 1 deg.
Should be white and volatilize without residue.
Must not become dark colored when agitated with concentrated sulphuric acid.
Should not contain phenols or quinoline bases.
Crystals should be dry and rattling without adhering oils.
Packed in ordinary barrels containing 200 lb. with brown paper lining.

Potassium Permanganate Commercial:

Commercial crystal.
Color, bronze to steel blue.
Commercial purity average 96 to 99 per cent $KMnO_4$.
Allowable impurities are small amounts of KCl and MnO_2 derived from the process of manufacture.
Unallowable impurities—sulphates.
Packed in cans or drums in accordance with the I.C.C. regulations regarding oxidizing materials.

Sodium Cyanide:

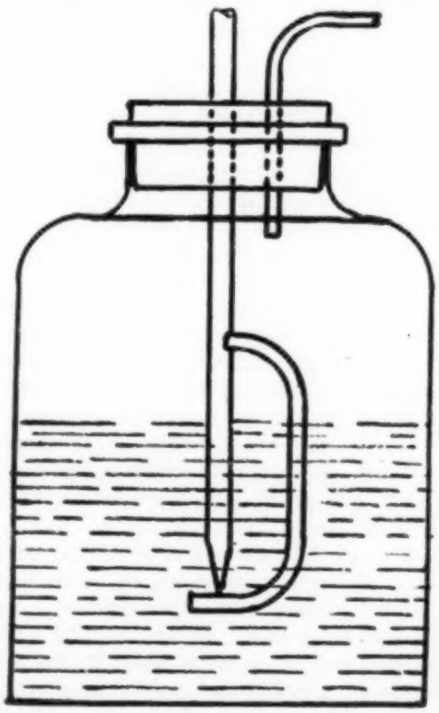
Commercial 96 to 98 per cent pure white crystalline lumps.
Melting point 560 deg. C.
Boiling point above 800 deg. C.
Sp.gr. 1.53.
Should contain 96 to 98 per cent NaCN.
Impurities 2 to 4 per cent.
Allowable impurities—carbonates, hydrates or cyanates.
Unallowable impurities—chlorides and sulphides.
Packed in tin lined boxes or sheet iron drums, hermetically sealed.

Sale of Picric Acid Plant

Bids on the Government picric acid plant at Brunswick, Ga., will be opened May 20. The plant consists of a 2000-acre tract on which are located all the buildings necessary for its operation. Prospective bidders will be given all the facilities for inspecting the property by applying to the Cincinnati District Salvage Board, Cincinnati, Ohio.

Synopsis of Recent Chemical and Metallurgical Literature

Determination of SO_2 in Gases.—In the determination of sulphur dioxide by the iodine method, the chief error encountered is the tendency to rush the gas through the iodine solution too quickly for the interaction between the SO_2 and iodine to be complete, with consequent erroneous results. To overcome this difficulty MR. O. D. BURKE (*Chemical News and Journal of Physical Science*, Dec. 6, 1918) used the following apparatus: A narrow glass tube is drawn out at one end into a very fine capillary, which is ground level at the point or end. Another glass



APPARATUS FOR DETERMINATION OF SO_2 IN GASES

limb is fused on to the straight limb and extends downward to just beneath the capillary, where it is flattened out and the top surface ground. The capillary is made to fit tight on the flat ground surface of the second limb. In this way the gas passing through the capillary tube is broken up into very fine bubbles no larger than a pin point; also the space is so restricted for the passage of the gas that no rushing through can take place, and the time interval for the passage of a certain volume of gas is identical in all cases, thereby with just ordinary care insuring extreme accuracy. This apparatus will prove a valuable addition to laboratories where SO_2 and many other gases are to be determined accurately.

Oxygen as a Revolutionizer of Industry.—The recent extraordinary progress in the industry of nitrates, based on the fixation of atmospheric nitrogen, is accompanied by the production of cheap oxygen as a by-product. In a paper read before the Société de l'Industrie Minérale, M. F. LAURE outlines the importance of the part this cheap oxygen will be called upon to play in the development of industry (*Bulletin et Comptes Rendus* de le Société de l'Industrie Minérale, 3éme livraison, 1918).

Besides the existing industries using oxygen, such as autogenous welding, manufacture of precious stones, metal cutting, medicines, etc., the following new uses are in view. Gas lighting will be revolutionized, as a Welsbach lamp using illuminating gas admixed with oxygen will give a light intensity of more than ten times that obtained when using only illuminating gas. Hence new forms of burners and economy of fuel will result. In metallurgy oxygen admixed to the air blown into the furnace will increase considerably the temperature and the efficiency of fuel, and also permit the use of cheaper qualities of fuel. Calcium carbide will be produced in blast-furnaces by purely thermic methods. Alumina will be reduced by carbon. Auriferous quartz will be melted. The glass industry will be revolutionized by the easy fusing of all forms of quartz. The thermal efficiency of the use of coal will be so improved that a new chemistry intermediary between the old chemistry and the chemistry of the electric furnace will be created. The manufacture of sulphuric acid will be much accelerated by a powerful oxidation of sulphurous acid. The cheap production of ozone, or electrified oxygen, will enable its greater use, notably for the sterilization of drinking water and the maintenance of a practically constant purified atmosphere in homes, public places, factories, mines, etc.

Scarcity of Raw Materials in Germany.—How hard it is on the German industry to keep up with the conditions of having the raw materials supply cut off is shown by the following few examples: For copper, they use a cupriferous schist of 0.7 to 1 per cent copper, instead of the previous 2.5 per cent. For lead, a variegated sandstone containing some lead carbonate, which before has been considered useless, is now worked, although it entails a loss of 40 to 50 per cent in lead. For aluminium they use a poor quality of bauxite and even clay. Wolfram is now obtained from wolframite with 0.06 per cent instead of the former 1 per cent wolfram. Vanadium is recuperated from slags with 0.7 per cent vanadium. Their present supply of chrome is a chrome ore of 24 per cent Cr_2O_3 instead of the former 48 per cent ore. Nickel and cobalt are obtained from waters pumped out of mines in which they are dissolved. For sulphur they use a 41 per cent pyrite instead of the former 52 per cent, also gypsum and anhydrite. They work phosphates with as low as 20 per cent content instead of the former 80 per cent (*Métaux, Alliages et Machines*, Mai, 1918). There is no doubt that the metallurgical improvements required under such conditions will be ultimately of a general benefit to the efficient use of the present mineral wealth.

Recent Progress in the French Chemical Industries.—Besides the progress realized during the last few years in the pre-war existing industries, special attention has been given to the manufacture of products heretofore imported from Germany. Among these the most important are: The production of magnesium, asbestos and rubber jointing materials, permanganate of potassium, pentasulphide of antimony, sulphide of sodium, which has replaced the sulphide of arsenic in tanneries; polishing powders for metals,

glass, aluminium, bleaching liquids (extracts of javel), calcium carbide, etc. The production of sulphuric acid has increased from about 850,000 tons per year in pre-war times to about 2,000,000 tons per year, and 3000 tons per year of oleum, and is still on the increase. The manufacture of nitric acid has increased from about 12,000 tons per month to about 50,000 tons per month. The production of hydrochloric acid has grown to such an extent that there is now available a great surplus, and the liquid chlorine industry, which was nil before the war, is now capable of manufacturing about 15,000 tons per year (*Génie Civil*, Nov. 9, 1918).

Water-Power Resources in Norway.—The following is an abstract of a paper published in the *U. S. Commerce Reports* of March 13, 1919. The power available for development in Norway is estimated at about 15,000,000 hp. The utilization of this water power on a large scale started about 15 years ago, and by this time it is estimated that 1,300,000 is used. The State has bought a great number of waterfalls in all parts of the country, with the intention of electrifying the State's railways. Of the 1,300,000 hp. already developed, 1,100,000 is in private ownership and 200,000 belongs to different communities.

The main Norwegian industries depending upon hydro-electric power are: The saltpeter industry, mostly in the Telemarken district of Southern Norway. More than 300,000 hp. is used for making nitric acid, Norwegian saltpeter and other nitrates and nitrites. The manufacture of calcium carbide is the oldest electrochemical industry of the country, and the production is growing yearly, necessitating the construction of several plants at different places. The present yearly production is about 100,000 tons. The American company has a concession to use 84,000 hp. in the district of Stavanger, and a large plant for utilizing this power is now being built. The several ferrosilicon plants produce about 30,000 tons per year, and the production of ferro-alloys, aluminium, zinc and similar products is continuously increasing. Norway possesses more water power in proportion to its population than probably any other country. The developed horsepower per capita is larger than in any other country—more than 0.5 hp. for every person in the country.

Treatment of Waste Liquors From Paper Pulp Mills.—The solution of the problem of converting factory waste into valuable by-products has enabled more than one industry to prosper in the face of severe competition. While conditions have not reached this point in the paper industry, the problem is nevertheless an important one because of the enormous tonnage of waste.

As has been the case in other industries, the first steps were taken, not with a view to the recovery of valuable material, but because of legal difficulties arising from older practices[1]. Thus in England prior to 1876, the waste liquor was allowed to flow into the streams. The introduction of the rivers pollution act compelled the paper manufacturers to adopt other methods for the disposal of their waste. It was soon found that, by evaporating the liquors to dryness and calcining the residue, from 90 to 95 per cent of the alkali used could be recovered in the form of carbonate. While this treatment was satisfactory in that it conformed with the law and at the same time permitted the recovery of alkali, it was inefficient from the standpoint of by-product recovery, as only the inorganic material was reclaimed. It has been pointed out[2] that, for every ton of dry pulp made, a ton of organic matter is discharged with the waste. As soda and sulphite pulp production in 1914 was 1,500,000 tons[3], the value of utilizing the organic material is self-evident.

During the last few years, several developments have been made along this line. Alcohol has been produced by fermenting the carbohydrates in neutralized sulphite liquor.[4] In Sweden, the lignin is precipitated and used as fuel.[5] The neutralized liquor has also been evaporated and used as a binder for roads, briquettes and as a tanning material, under the name of glutrin[6].

Recently, a number of patents have been granted which are assigned to the West Virginia Pulp & Paper Co.[7] and which indicate some of the possibilities of research in this field.

Black liquor from the caustic soda process of producing pulp is concentrated in multiple effect evaporators until the water content is about 50 per cent and the sp.gr. 1.32. In some cases, as when working with sulphite liquors, it may prove advantageous to add a small amount of caustic soda during the concentration process. About 50 per cent of quicklime is now added to the liquor in a rotary mixer. The slaking of the lime evolves sufficient heat to convert a portion of the water into steam, which in escaping renders the mass porous. Also the sodium compounds are causticized.

This porous causticized calcareous ligneous acetate material, which is termed calignate, weighs only 38 to 40 lb. per cu.ft., whereas the true specific gravity of the material is 1.9. Its strength under compression is from 612 to 987 lb. per sq.in., and the material will retain its form up to 500 deg. C.

Distillation of calignate in a revolving retort at 600 to 700 deg. C. in the presence of superheated steam yields acetone[8], along with other ketones, heavier oils, ammonia and fixed gases which may be used as fuel. When calignate is made with black liquor from poplar wood, yields of acetone and methyl alcohol up to 5 to 10 per cent of the weight of organic material present have been obtained. Leaching the residue with water recovers the sodium hydroxide, while heating in a rotary kiln converts the final residue into quicklime.

Calignate is heated to 250 deg. C. in a closed retort so that methyl alcohol, moisture, etc., are driven off, without, however, decomposing acetates present. The mass is cooled in the absence of air, extracted with hot water, and the resulting solution concentrated to 30 to 32 deg. B. Carbon dioxide is passed into the solution and the $NaHCO_3$ which crystallizes out is filtered off. The solids in solution now contain sodium acetate, 50 per cent; sodium and potassium salts of lactonic acids, 25 per cent; black coloring matter, 10 per cent; $NaHCO_3$, 5 per cent; NaCl, 10 per cent. The sodium acetate amounts to 10 to 12 per cent of the weight of the calignate. After neutralizing the solution with acetic acid, the coloring matter is precipitated with lime and the sodium acetate recovered by evaporation and crystallization. The sodium acetate in the mother liquor is

[1]Cf. Cottrell Process; CHEM. & MET. ENG., XX, p. 103.

[2]CHEM. & MET. ENG., XIX, p. 213.
[3]Abstract of the Census of Manufactures, 1914, p. 156.
[4]CHEM. & MET. ENG., XVIII, p. 360; see also XIX, p. 97.
[5]CHEM. & MET. ENG., XIX, p. 213.
[6]CHEM. & MET. ENG., XIX, p. 568.
[7]U. S. Pat. 1,298,476-1,298,481 incl.; 1,298,594; Mar. 25, 1919.
[8]Cf. CHEM. & MET. ENG., XX, 190.

decomposed with an equivalent amount of H_2SO_4, the Na_2SO_4 crystallized out and the acetic acid distilled off.

The lactonic acids may now be recovered either as their alkali salts or as the free acids.

When waste sulphite liquor is digested for several hours with 2 to 6 per cent of caustic alkali in a rotary digester under 80 to 100 lb. pressure, the woody material is converted into lignin and some of the sugars present are apparently transformed into lactonic acids which give acetone and other ketones and alcohols on distillation.

The precipitation of the lignin in a form which can be easily filtered is facilitated by passing in carbon dioxide. The lignin represents about 30 per cent of the dry weight of the organic matter in the original liquor and may be used as a tanning material or as an inert filler for paint, linoleum and other products. The filtrate may be converted into calignate by the method outlined above.

Specifications for Leather Belting.—In view of the quantity of leather belting used in the industries for the transmission of power, it seems remarkable that practically no specifications exist which are applicable to modern practice. That such is the case, however, is pointed out by HARRY A. HEY in *Industrial Management* for April, 1919, and he endeavors to supply the deficiency by outlining a set of specifications which has been in satisfactory operation for the purchase of a large amount of belting during the past three years.

In drawing up these specifications, due consideration has been given the fact that the raw material itself is of a variable nature and that, during manufacture, the human element is introduced to a greater extent than in many industries. Furthermore, the requirements should cover the best commercial practice and no more, lest they defeat themselves through the inability of manufacturers to live up to them.

1. These specifications are intended to cover first-quality, center-stock, oak-tanned leather belting for general use. Previous specifications are hereby cancelled.

2. The material and workmanship must be guaranteed by the vendor to be of the highest quality and the finished product equal in strength, pliability, durability and performance in use to any obtainable.

3. The purchaser reserves the right to subject each roll of belting when received to the following tests. Failure to pass any of them will be cause for the return of the entire roll for full credit, plus carrying charges both ways. The manufacturer's name and brand must be stamped on all belts every ten feet and the length every foot.

4. When unrolled freely on a flat surface, without tension, the belt must lie flat at all points and be full length as marked. There must be no evidence of injurious surface blemishes, artificial finish to produce high polish, shimming or excessive leveling, cracking when bent grain side out through 180 deg. over a $\frac{1}{2}$-in. diameter rod for single belts and a 1-in. rod for double belts, or piping when similarly treated grain side in.

5. No section shall be longer than 54 in. or shorter than 42 in., including laps, except in double belting, where shorter pieces may be used provided they do not exceed 10 per cent of the total number of laps.

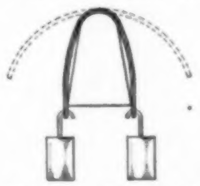
6. (*a*) Thickness must not vary more than $\frac{1}{32}$ in. (*b*) Width must be within $\frac{1}{32}$ in. of nominal size.

7. Character of leather must be uniform throughout the entire length of the belt.

8. One or more test pieces 1 in. wide will be cut at random lengthwise of the belt. Each test piece must show a tensile strength in pounds per inch of width not less than the following table. The vendor may furnish any thickness or weight of belting which will meet this requirement. Total elongation at the required load must not be less than 15 per cent or more than 20 per cent in 2 inches:

	Single			Double		
	Under 2 Inches	2 to 4 Inches	Over 4 Inches	Under 4 Inches	4 to 8 Inches	Over 8 Inches
Light	580	605	630	900	1000	1100
Medium	630	675	720	1100	1200	1300
Heavy	720	765	810	1300	1400	1500
Extra heavy	810	900	990	....	....	....

9. Cemented joints must not crack or yield before reaching a load equivalent to 90 per cent of the tensile strength specified in paragraph 8.



PLIABILITY TEST

10. A section 40 in. long and the full width of the belt will be tested for pliability by being suspended over a form of the dimensions shown, grain side down, and weighted at each end. Both ends must touch the bottom corners at a total weight per inch of width within the following limits:

	Minimum, Ounces	Maximum, Ounces
Light, single	8	15
Heavy, single	10	20
Light, double	45	60
Heavy, double	60	80

11. The total lubricating matter shall be increased by oil dressing to approximately 12 to 15 per cent by weight when examined in accordance with the practice of the American Leather Chemists' Association. Chemical examination shall not show loading for artificial weight, free mineral acid or anything detrimental to the strength, pliability or durability of the belt.

12. Belting must not run unevenly on the pulleys, show excessive stretch or develop other defects of material or workmanship in service, when properly applied.

For a complete discussion of the points covered by these specifications, reference should be made to the original article, but the following notes may call attention to the more important points. The numbers refer to the individual specifications.

Strength.—Center stock is the area of a prime steer hide extending from 15 to 18 in. on either side of the backbone and from the root of the tail about 48 in. toward the shoulder. Strength should be expressed in pounds per inch of width, instead of pounds per square inch (1, 5 and 8).

Pliability.—A stiff belt may be so badly burned by excessive slip when new as to shorten its life considerably. In order to transmit a given load, a stiff belt has to be tightened more than a pliable one, with the result that the increased bearing pressure consumes more power (10).

Artificial Finish.—For the sake of appearance, many manufacturers give their belts a high gloss finish which has a low coefficient of friction. Such a belt is liable to slip when new and become burnt in the process. For the same reason, manufacturers do not send out their product oil dressed unless so requested, although the dressing increases the life of the belt, as well as its resistance to moisture, fumes, mineral oil and other destructive agents (4 and 11).

Recent Chemical and Metallurgical Patents

Leaching Kiln Dust.—EVALD ANDERSON, of Los Angeles, Cal., finds that if a cement kiln is fired with pulverized coal, the ash-forming substances tend to combine with the volatilizing alkaline oxides, forming a compound which is slowly soluble in water. He therefore proposes to treat the resulting dust in a digester with water at high temperature and pressure, finding that in many cases it will raise the potash extraction up to 90 per cent within one hour's time. Lime, either from the kiln dust, or as an added reagent, is also thought to aid the solution of the valuable potash. (1,298,154; assigned to International Precipitation Co., March 25, 1919.)

Silver From Manganese Ores.—MARTINUS H. CARON, of Weltevreden, Java, patents an improvement of his former process covered in No. 1,232,216. In silver and gold ores bearing considerable quantities of MnO_2, it is well known that cyanide or amalgamation processes yield very poor extraction, possibly because of a compound between gold, silver and manganese. Caron proposes to break up these compounds, forming MnO and metallic silver or gold by a reducing roast at some temperature up to 1000 deg. C. which experience with that particular ore indicates, and then preventing reoxidation and recombination by cooling the calcine in producer gas or otherwise out of contact with oxygen. Thereafter cyaniding or amalgamation in the ordinary way will give good extractions. (1,298,454; assigned to Research Corporation of New York, March 25, 1919.)

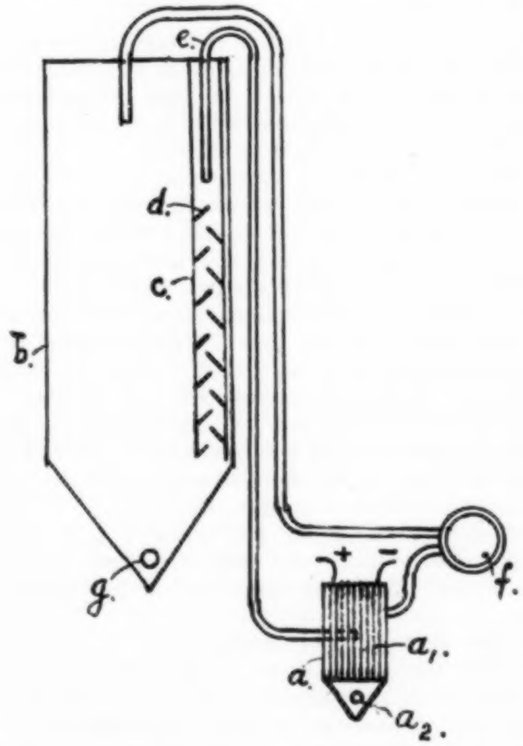
Steel Heat Treatment.—FEDERICO GIOLITTI, of Turin, Italy, patents an improvement in heating practice prior to quenching steel articles, in which he specifies that the metal be held at a point near that where diffusion of the constituents takes place with the greatest rapidity (i.e., at least 100 deg. C. above Ac_3) for a time depending upon the mass and shape of the piece. He then cools the furnace slowly to at least 30 deg. C. below the temperature necessary for effecting the ordinary homogeneous hardening (i.e., at least 50 deg. C. above Ar_3), holding the temperature constant for a somewhat shorter time, and then quenching the metal in a suitable medium. Following this, any correct tempering or annealing practice may be utilized to modify the resulting physical properties. Several practical examples are cited from experiments conducted to determine the best time and temperature limits. (1,296,649; assigned to Giov. Ansaldo & Co., Genoa, Italy, March 11, 1919.)

Metal Dust.—M. H. NEWELL, of San Francisco, Cal., proposes to make zinc dust by vaporizing spelter in a retort and condensing the vapor direct to solid without passing through the liquid phase. He notes, however, that if vapors come into contact with hot condenser walls, droplets of liquid metal form, which introduce large particles into the otherwise finely divided fume, and he proposes to prevent this contamination by a large cylindrical metallic condenser, connected to the retort mouth with a connecting hood, which may or may not be heat insulated. (1,295,573; assigned to The Alloys Co., Feb. 25, 1919.)

Australian Patents

Ore Flotation.—To preferentially separate lead sulphide (galena) from mixed sulphide ores by agitation, aëration froth flotation, a ferric salt such as ferric chloride or sulphate or sodium or potassium ferricyanide is added to the circuit water, preferably in the proportion of 5 lb. per ton of ore treated. (Australian Patent, No. 5714—1918. BROKEN HILL SOUTH SILVER MINING CO., T. A. Read, assignee.)

Recovering Gold and Silver.—To directly precipitate gold and silver from pulped ore without filtering, the pulp is agitated in a cyanide vat *b* by an air jet *g* and is drawn off to an electrolytic vat through a compartment *c* which is provided with perforated baffle plates *d* to separate the coarser particles. A syphon *e* conveys the pulp to an open precipitating vessel *a* having an air inlet pipe a_2 to maintain the



ore in suspension, and provided with depending electrodes a_1, through which low-tension current is passed. A pump *f* returns the pulp to the cyaniding vessel. The anodes are of iron containing 30 to 40 per cent silicon, and the cathodes consist of lead coated iron or mild steel plates, which are about 1 in. apart. (A. A. LOCKWOOD, Australian Patent No. 7097—1918.)

Treatment of Zinkiferous Ores.—To facilitate the formation of a pure zinc sulphate solution, the zinc is volatilized and dissolved in sulphuric acid. Impurities such as arsenic, antimony and cadmium are precipitated by barium sulphide, or calcium sulphide which is thrown down as insoluble sulphate. The ore is crushed, roasted, damped and mixed with carbon, and is fed to a furnace provided with a perforated grate to admit an air blast. The zinc, lead and other volatile constituents are here volatilized, and the resulting fumes collected in a baghouse. The residue is smelted, and any remaining lead and zinc are volatilized and collected in the main baghouse, the

non-volatile metal being recovered in a matte. The fume dust is now treated with sulphuric acid, lead sulphate settling to the bottom and the clear liquor being decanted and treated with barium sulphide. The zinc is finally deposited by electrolysis and sulphuric acid liberated, and used again. Zinc plates are used as cathodes, and gum arabic is added to insure an even deposition of zinc. (Australian Patent No. 6456—1918. J. H. and P. McP. GILLIES. Feb. 5, 1919.)

Sulphur From Roaster Gases.—ARTHUR B. FOSTER, of Washington, D. C., has discovered that if SO_2 gases from a mechanical roaster, working on ordinary sulphide ores, be passed through a granular mass of sulphides heated to from 750 to 900 deg. C., elemental sulphur is slowly produced, perhaps after the following equation:

$$2SO_2 + 3FeS = 5S + Fe_3O_4$$

If steam be added to the roaster gases, the hot sulphides may decompose it thus:

$$4H_2O + 3FeS = Fe_3O_4 + 3H_2S + H_2$$

Hydrogen sulphide then actively decomposes SO_2 by the well known reaction:

$$SO_2 + 2H_2S = 2H_2O + 3S$$

The inventor finds that if the granular ore be placed in a vertical retort, and the lower portion heated to a point just below sintering, moist roaster gases will rapidly and almost completely be broken up. Cold gas and sulphur fume will then be drawn from the top, and sent to a Feld washer or other suitable appliance for collecting the sulphur. Hot ore from the retort, partially desulphurized, forms the feed for the mechanical roaster. (1,296,585; assigned to Sulphur Syndicate, Ltd., of London, Eng., March 4, 1919.)

Personal

The American Red Cross asks our assistance in locating LIEUT. WILLIAM H. STUART, son of Duncan C. Stuart, of 12 Maple St., Oneonta, N. Y., and will appreciate any information that can be secured relative to his whereabouts. Lieut. Stuart is 27 years of age. He arrived from overseas service on Jan. 13 and went to Washington, where he was given his discharge. He returned to New York, and was last seen in that city Jan. 18 at 7:30 p.m. He is a graduate of Colgate, class of 1914, and took two years' post-graduate work at Brooklyn Polytechnic Institute. He is 5 ft. 8 in. tall, has dark hair and blue eyes and a ruddy complexion. He has a brown mole on the left side of his nose. He has three gold service chevrons on his sleeve, if in uniform. He was wearing, when last seen, spiral puttees and not the customary leather ones for officers. Information relative to him may be sent to D. C. Stuart, 12 Maple St., Oneonta, N. Y.

MR. J. P. BONARDI, assistant chemist, U. S. Bureau of Mines, who has been at the Seattle station experimenting on flotation problems with W. H. Coghill, has returned to his assignment at the Golden, Colo., station.

DR. JAMES E. CAMPBELL, president of the Dexter Sulphite Pulp & Paper Co., Dexter, N. Y., has returned from Europe, where he spent three months on a semi-official visit for the United States Government investigating the chemical, mechanical and labor conditions in the paper and pulp industry in France, England, Norway and Sweden.

MR. GORDON L. CAVE, formerly on an editorial detail with the pyrotechnic section, research division, Chemical Warfare Service, has accepted a similar position with the research department, Brown Co., Berlin, N. H.

MR. VERDON O. CUTTS, Sheffield, England, is visiting electrometallurgical centers in the Eastern and Central States.

MR. HERBERT FLECK has been appointed chief chemist, Crucible Steel Co., Pittsburgh, Pa., succeeding his brother, Mr. E. M. Fleck.

DR. WILLIAM MCPHERSON, who was recently discharged from the Chemical Warfare Service of the U. S. A., has returned to his former position at the Ohio State University, Columbus, Ohio.

MR. A. H. RICHARDS has been made superintendent of the copper smelter at Garfield, Utah. Before becoming assistant superintendent at Garfield for several years he held a like position at the A. S. & R. lead smelter at Murray, Utah.

MR. H. M. ST. JOHN has resigned his position as research engineer for the Commonwealth Edison Co. of Chicago to become assistant manager for the Detroit Electric Furnace Co.

MR. JOHN THOMPSON, chief engineer of the H. Koppers Co., will be in Europe for several weeks on a professional visit at various points in the Allied countries.

MR. FRANK J. TONE, past president of the American Electrochemical Society, has been made president of the Carborundum Co., Niagara Falls, succeeding the late Mr. Frank W. Haskell. MR. GEORGE R. RAYNER succeeds R. B. MELLON as vice-president and MR. F. H. MANLEY retains the office of treasurer.

MR. WALTER HARVEY WEED is consulting engineer for the Crystal Copper Co., which is operating the Goldsmith mine at Walkerville, Mont.

The following officers of the New York Section of the A. I. M. E. were elected May 7: E. P. MATHEWSON, chairman; R. M. ATWATER, JR., and WILLIAM YOUNG WESTERVELT, vice-chairmen; WILBER JUDSON, treasurer; E. S. BERRY and L. W. MAYER, executive committeemen.

At the annual meeting of the Chemists' Club held at Rumford Hall Wednesday, May 7, the following officers were elected: President, ELLWOOD HENDRICK; resident vice-president, WILLIAM F. HOFFMAN; non-resident vice-president, VICTOR F. BLOEDE, of Baltimore; secretary, J. R. MACPHERSON KLOTZ; treasurer, HENRY M. TOCH; trustees to serve three years, EDWARD WESTON and ALLEN ROGERS.

Current Market Reports

The Non-Ferrous Metal Market

Saturday, May 10.

Aluminium:—The open market is nominal at 33c. Sheets 18 gage and heavier, 42c. Powder, 0.70-1.40 lb.

Copper:—The market continues to be quit with 15½c. being the uniform price.

Copper sheets, hot-rolled	lb.	\$0.22½—	.....
Copper sheets, cold rolled	lb.	.23½—	.....
Copper bottoms	lb.	.23½—	.....
Copper rods	lb.	.19½—	.....
Copper wire	lb.	.17½—	\$0.18
High brass wire and sheets	lb.	.18¾—	.....
High brass rods	lb.	.17¾—	.....
Low brass wire and sheets	lb.	.18¾—	.....
Low brass rods	lb.	.21¼—	.....
Brazed brass tubing	lb.	.29½—	.....
Brazed bronze tubing	lb.	.33¼—	.....
Seamless copper tubing	lb.	.28 —	.....
Seamless bronze tubing	lb.	.29½—	.....
Seamless brass tubing	lb.	.30 —	.....
Bronze (gold) powder	lb.	1.00 —	.....

Antimony:—No spot antimony is now available at 7c., though prompt shipments from the Orient can be obtained at this price.

Lead:—Market is inactive. East St. Louis quotes 4¾c. and New York 4.5 to 5c. Sheet lead, 7⅝c.

Tin:—The price of 72½c. continues; however, when the price does change, it will be because the allotment has been consumed, and no previous notice is likely to be obtainable.

Zinc:—Spelter has gone down as low as 5.95c. during the past fortnight, and is now quoted at 6c. at East St. Louis. New York, 6.45c. Zinc dust, 9c. Sheets, 11c.

OTHER METALS

Bismuth	lb.	$3.20	$3.65
Cadmium	lb.	1.40	......
Cobalt	lb.	2.50	3.50
Magnesium	lb.	1.75	2.10
Mercury	75 lb.	80.00	......
Nickel	lb.	.40	.45
Tungsten	lb.	Nominal	
Iridium	oz.	175.00	......
Palladium	oz.	120.00	121.00
Platinum	oz.	99.00	100.00
Silver	oz.	1.05½	......

The Iron and Steel Market

The basic situation in the iron and steel market has not changed, but the atmosphere has been somewhat cleared by the final exit from the stage of the Industrial Board at Washington. The board had got into a hopeless tangle in its "controversy" with the Railroad Administration, desiring the latter to endorse prices for steel which the railroads considered too high, and to participate in a price maintenance movement which the Attorney General had declared in a formal opinion he considered illegal, a fact which the Industrial Board did not divulge, and only came out in a statement by its ex-chairman after he had resigned.

The resignation of the Industrial Board destroys any connection it may have been thought existed between Washington and the maintenance of steel prices. Nothing has occurred in the steel market as a result of the disappearance of the board. Now, as formerly, steel prices rest upon the general understanding of the steel producers individually that it is for their best interest to maintain existing prices, reduced from war-time prices as they have been by about $4 a net ton in December and $7 a net ton in March.

Steel Prices

If steel prices advance it will be because of a general buying movement starting on the present level. Never in the course of steel market history has a general buying movement, with advancing prices, started except after a break to abnormally low levels. Buyers have confidence in the market only when it is advancing. In all the market dips that have occurred little steel has been sold at the low point.

If steel prices decline it will be the result either of an accident, through one or more producers departing from the present understanding, or through the leaders in the trade reaching a judgment that the time has become ripe for starting a movement. The producers do not hesitate to cut prices if they feel certain that thereby they can set the market in motion. If they maintain present prices longer than necessary it will be through incorrect judgment due to their being less sanguine as to the future of business than they should be. If they allow the market to break before buyers are ready to take hold in a large way they will lose money through producing steel at less than cost, including overhead, when by maintaining prices they would have been able to make their overhead.

Operations

In April, according to the monthly report of the American Iron and Steel Institute, 2,239,711 gross tons of steel ingots were produced by 30 companies which in 1918 made 84.03 per cent of the country's entire output. From this it may be computed that the industry made steel in April at the rate of about 31,900,000 tons per annum, which was 65 per cent of capacity, taking capacity at 49,000,000 tons a year. This compares with 77 per cent in March, 85 per cent in February and 87 per cent in January. At the same rate of progression the operating capacity at the middle of May would be 53 per cent, while current trade estimates would place the rate at about 55 per cent.

There is a wide divergence in operating rates. The Steel Corporation is operating at a heavier rate than the independents as a whole, and in some cases it is doing so by operating some plants almost in full, with others entirely idle. In some branches, as the sheet and tin plate branches, the corporation is distributing work uniformly at each plant. Among the large independents the rate of operation is more commonly 40 or 45 per cent than a higher rate, while a few small interests are operating almost full, others being entirely idle. This divergence in operating rates makes price maintenance less easy than it was in 1908, when all producers operated at substantially the same rate.

Some Improvement

There has been improvement in the steel market in some respects, but increases in the volume of new bookings are usually more than offset by the exhaustion of old orders. Only two classes of consumers show full normal demand, these two being the automobile trade and the petroleum industry.

An important factor in the situation is the fact that steel making capacity has increased 40 per cent since 1914 and 100 per cent since 1907. On the one hand it would appear that a very large demand for steel would be necessary in order to give the industry a full operation at this time. On the other hand it is clear that if the greatly enlarged industry can operate even at 55 per cent when there appears to be scarcely any demand it would be no remarkable thing for a turn in affairs to bring about demand for the fullest output possible.

While the steel producers have such objections to an open market for their product that they can adhere to the existing schedule without any formal agreement to that effect, the merchant furnaces declared long ago that they regarded their market as an open one, and individual furnace interests frankly declare their willingness to cut prices if attractive orders are to be secured. Inquiries have been so small individually, however, that there has been but little price cutting. The furnaces do not specifically desire lower prices, but they desire information. They would like the market to show where it desires to go, and as promptly as possible, whereupon the furnaces individually can decide whether or not to blow out and await either lower costs or higher prices. Many have already done so. With relatively few exceptions the pig iron prices effective March 21 still obtain, while in steel the March 21 schedule is in full force, and well maintained.

The Chemical Market

New York, May 10.

Coal-Tar Products:—There has not been a great deal of change in this situation during the interim. The crudes continue to be moving in large quantities, and the situation in general is somewhat more encouraging than it was a few months ago. Benzol is moving in large volume, with contracts for quantities being closed right along. The other crudes also appear to be on a more stable basis, and the price situation, while unchanged in general, is firmer. It is not unlikely that higher prices will prevail when the large stocks held by the Government are disposed of. The intermediates, however, are sluggish and weak, with consumers confining their purchases to immediate requirements.

Benzol:—An unusually heavy volume of business is passing in this market. Several of the smaller plants are not operating, and while material is not scarce, it is not being offered as liberally as formerly. Prices are firm, though unchanged. Spot material is available only in limited quantities.

Phenol:—Some large sales have been closed of late, and though material is plentiful, the elimination of stray lots in the hands of weak holders has stimulated the market somewhat and prices are slightly higher.

Naphthalene:—While there is an improvement in the demand for spot and nearby material, there are but few large contracts being closed. Material is plentiful and prices are unchanged though slightly firmer.

Toluol:—There is a fair demand for moderate quantities of drum material, although there is but little business passing in tank-car lots. Buyers in most instances are closing only for current requirements. Prices are slightly firmer due to curtailment in production.

Cresol:—A steady volume of business is passing through regular channels, but there is no unusual activity. Prices are unchanged, and if anything are slightly easier.

Metol:—The domestic production of this material is now perfected to the state where a regular supply is possible.

There are moderate quantities of the foreign grade available, but prices are so much higher than those for domestic goods that the domestic is favored.

Alpha Naphthol:—There is an improvement in the volume of business passing, but there are large quantities of material available and prices are barely steady.

Aniline Oil:—The volume of business passing is not at all heavy; there is plenty of material available and prices are slightly easier.

Dimethylaniline:—The demand is confined to moderate and small quantities. The supply is ample with prices unchanged.

Diethylaniline:—Small quantities are passing hands, but the demand is not brisk and prices are unchanged.

Paranitraniline:—There are more concerns producing this material at present than formerly and contracts have been placed at low figures of late; spot prices, however, are practically unchanged.

Dinitrochlorbenzol:—An improvement is noted in the demand, but it is mostly confined to small quantities, with the supply ample; and prices unchanged.

Dinitronaphthaline:—Small lot trading appears to feature the market, the demand in the aggregate is not heavy and prices are not more than barely steady.

HEAVY CHEMICALS:—Trading continued during tne past two weeks along the same moderate lines that has been evident for some time. It was asserted that many of the largest consumers are covered by existing contracts, while on the other hand where contracts have terminated, buyers in many instances are not disposed to enter new agreements over the year, but shop the market, and supplies are easy among second hands at prices materially lower than those of manufacturers. Therefore little interest is manifested by consumers in forward stocks and the entire situation, so far as heavy chemicals are concerned, still seems to be controlled by second hands. Export demand has not been very active, although there seems to be more life in trading in this direction, but the anticipated volume of orders that have been looked for has yet to appear in the market. The current movement for local consumption continues mostly of a routine nature and buyers retain a conservative policy.

Soda Ash:—The item has been very much neglected during the interval. Light ash sales were of a minor character with virtually no call for dense ash in any important quantities. Bags from the warehouse sold during the week at $1.50 for carload lots, but sales of this character were few and 5 and 10 ton lots were sold at $1.65 to $1.70 ex-warehouse. There has been little call for barrel material with isolated offerings noted from the warehouse at $1.60, which was an extremely low figure, while other resale lots were held at $1.70 to $1.75. Double bags were available during the week at 2c. Middle West, with material in the warehouse at San Francisco and Seattle being offered at $1.90 with no interested buyers.

Caustic Soda:—There was not much doing for this chemical, although some spasmodic activity was noted and sales were consummated through second hands as low as $2.50 for warehouse material, with 25 and 50 ton lots having sold during the week at $2.60 f.a.s. At the close some isolated offerings by weak holders were made at $2.50 ex-store, while in most instances $2.55 to $2.60 was asked for resale material. First hands were offering caustic soda at $2.80 f.a.s. early in the week, but toward the latter end were asking 3c. This advance seems to have affected the resale market, and despite the fact that offerings were liberal among second hands, there was no disposition to shade prices to stimulate business.

Bleaching Powder:—Producers continue to report a moderate inquiry for this commodity for export purposes and keen competition between second hands and producers alike has resulted in some lively bidding to close business. Some sales were consummated at low levels, by second hands, who still seem to be in a position to offer below manufacturers' figures. First hands were offering fresh material in export drums at $1.75 f.a.s., while domestic drums were quoted at $1.40 Niagara.

Bichromate of Soda:—Conditions in this market show no indication of any firming up in the situation, with sales for outside brands noted during the week at 8c. for spot material. Standard brands were offered by second hands at 9c. to 9¼c., while manufacturers were making an effort to keep the market up at 9½c.

Bichromate of Potash:—Although the present rate of absorbing stocks is having no effect on available supplies, producers report a slightly better movement for the product, particularly for export purposes, while local purchasing is apparently confined to immediate needs. In this instance the resale market offers material at 33½c. ex-store or f.a.s., which is ½c. lower than prices quoted by manufacturers.

Chlorate of Potash:—The recent lack of demand has had its effect in this market, with sales reported as low as 27c. for material for immediate shipment from the works, while spot material was offered at 29c., which was a decline of 4c.

Bicarbonate of Soda:—While there has been nothing in the way of any important trading passing for this commodity, there seems to be a sufficient call for the product to take the slack off the market. Stocks, however, are more than sufficient for the current call, but have not accumulated in any large surplus. Barrels at the works were offered at $2.30, while spot material was available at from $2.35 to $2.40. Kegs were quotably unchanged in price at $2.65 ex-warehouse.

Caustic Potash:—Reports of price cutting for the Western material has seemingly had no effect on the standard brand of this product, which is held firmly at 50c. for the 88-92 test, while sales of the other grades were noted as low as 40c. for the same test. Despite the variation of price, many consumers prefer the standard electrolytic product.

Chicago, May 10.

Although the connection between the Liberty Loan campaigns and the chemical market is hard to establish, it is a fact proved by previous experience that the drives have a tendency to slacken sales. The present drive for Victory Bond sales is no exception, the past two weeks showing but little activity in Chicago.

In general, conditions seem to be improving. Overstocks are gradually being used up, which is causing a gradual strengthening in the entire line of heavy chemicals. As was foreseen in the last report from this district, the bottom seems to have been reached and it is merely a question of time until all items which have been selling at less than cost of production will return to a reasonable quotation.

Caustic soda continues to be about the weakest item in the market, it still being possible to buy at an absurdly low figure, though it is showing some tendency to stiffen. Carbolic acid is still plentiful at less than cost, but it can no longer be had for the mere cost of containers. In the acids, sulphuric and muriatic have reached approximately their pre-war standing and should remain there. Ammonia and nitric acid are still slightly above the pre-war price, but seem to be inclined the same way.

Coal-tar products and their derivatives have taken an upturn, 90 per cent benzol bringing 25c. and being in fairly good demand. In this line the recently noted tendency of buyers to follow a hand-to-mouth policy is not so pronounced, the consumer who studies underlying conditions evidently being convinced that no lower prices are coming, but that, on the contrary, an increase may be definitely looked for.

Vegetable oils, particularly soap stocks, are in excellent demand, with prices firm and no reductions in sight.

Flotation Oils and Naval Stores:—Prices remain very firm with demand equal to if not in excess of supply. Steam distilled pine oil, 0.933 test pure, has registered an advance of 5c., now being sold at 75c. in barrel lots, 72c. in carloads. Lower test stuff is offered at from 4 to 6c. less. Hardwood creosote is unobtainable in this market, a bona fide purchaser last week being forced to go with his want unfilled. Turpentine continues scarce, there being sufficient to supply actual needs, however, at a firm market of 68c.

General Chemicals

WHOLESALE PRICES IN NEW YORK MARKET MAY 12, 1919

Acetic anhydride	lb.	.55	—	.60
Acetone	lb.	.15½	—	.16
Acid, acetic, 28 per cent	cwt.	3.00	—	3.25
Acetic, 56 per cent	cwt.	6.00	—	7.00
Acetic, glacial, 99½ per cent, carboys	cwt.	12.00	—	14.00
Boric, crystals	lb.	.13¼	—	.14½
Boric, powder	lb.	.13½	—	.14½
Hydrochloric, tech. 20 deg.	cwt.	1.50	—	3.00
Hydrofluoric, 52 deg.	lb.	.08	—	.08½
Lactic, 44 per cent. tech.	lb.	.12½	—	.13
Lactic, 22 per cent. tech.	lb.	.05½	—	.06
Molybdic, C. P.	lb.	6.50	—	7.40
Nitric, 40 deg	lb.	.06	—	.07
Nitric, 42 deg	lb.	.07	—	.08
Oxalic, crystals	lb.	.27	—	.30
Phosphoric, Ortho, 50 per cent. solution	lb.	.07½	—	.10
Picric	lb.	.50	—	.60
Pyrogallic, resublimed	lb.	2.55	—	2.70
Sulphuric, 60 deg., tank cars	ton	11.00	—	13.00
Sulphuric, 60 deg., drums	ton	17.00	—	.....
Sulphuric, 60 deg., carboys	ton	20.00	—	.....
Sulphuric, 66 deg., tank cars	ton	16.00	—	20.00
Sulphuric, 66 deg., drums	ton	21.00	—	.....
Sulphuric, 66 deg., carboys	ton	25.00	—	.....
Sulphuric, fuming, 20 per cent. (oleum) tank cars	ton	22.00	—	25.00
Sulphuric, fuming, 20 per cent. (oleum) drums	ton	25.00	—	.....
Sulphuric, fuming, 20 per cent. (oleum) carboys	ton	30.00	—	.....
Tannic, U. S. P.	lb.	1.40	—	1.50
Tannic, (tech)	lb.	.42	—	.60
Tartaric, crystals	lb.	.86	—	.87½
Tungstic, per lb. of WO_3	lb.	1.60	—	1.75
Alcohol, Ethyl	gal.	4.00	—	4.85
Alcohol, Methyl	gal.	1.25	—	1.30
Alum, ammonia lump	lb.	.04	—	.05½
Alum, potash lump	lb.	.08½	—	.10
Alum, chrome lump	lb.	.17½	—	.18
Aluminium sulphate, commercial	lb.	.01¾	—	.03
Aluminium sulphate, iron free	lb.	.02¾	—	.03½
Aqua ammonia, 26 deg., carboys	lb.	.06½	—	.09
Ammonia, anhydrous, cylinders (100-150 lbs.)	lb.	.30	—	....
Ammonium carbonate, powder	lb.	.12½	—	.13½
Ammonium chloride, granular (white sal ammoniac)	lb.	.13½	—	.14
Ammonium chloride, granular (gray sal ammoniac)	lb.	.14	—	.16
Ammonium nitrate	lb.	.17	—	.20
Ammonium sulphate	lb.	.05½	—	.06
Amyl acetate	gal.	3.50	—	3.75
Arsenic, oxide, lumps	lb.	.09	—	.09½
Arsenic, sulphide, powdered	lb.	.30	—	.32
Barium chloride	ton	70.00	—	80.00
Barium dioxide (peroxide)	lb.	.22	—	.24
Barium nitrate	lb.	.10	—	.11
Barium sulphate (precip.) (blanc fixe)	lb.	.02½	—	.03½
Bleaching powder, (see calcium hypochlorite)		....	—	....
Blue Vitriol (see copper sulphate)	lb.	.08	—	....
Borax, (see sodium borate)		....	—	....
Brimstone, (see sulphur, roll)		....	—	....
Bromine	lb.	.55	—	.60
Calcium acetate	lb.	.04	—	.05
Calcium carbide	lb.	.05½	—	.06
Calcium chloride, fused, lump	ton	19.00	—	21.00
Calcium chloride, granulated	lb.	.02	—	.02½
Calcuim hypochlorite, (bleaching powder)	cwt.	1.50	—	2.00
Calcium phosphate, monobasic	lb.	.22	—	.23
Calcium peroxide	lb.	1.50	—	1.70
Calcium sulphate, precipitated	lb.	.09	—	.09½
Carbon bisulphide	lb.	.06½	—	.08
Carbon tetrachloride, drums	lb.	.13¾	—	.14½
Carbonyl chloride (phosgene)	lb.	.75	—	1.00
Caustic potash, (see potassium hydroxide)		....	—	....
Caustic soda, (see sodium hydroxide)		....	—	....
Chlorine, gas, liquid-cylinders, (100 lb.)	lb.	.06	—	.08
Cobalt oxide	lb.	1.60	—	1.65
Copperas (see iron sulphate)		....	—	....
Copper carbonate, green precipitate	lb.	.28	—	.31
Copper cyanide	lb.	.65	—	.70
Copper sulphate, crystals	lb.	.07¾	—	.08
Cream of tartar, (see potassium bitartrate)		....	—	....
Epsom salt, (see magnesium sulphate)		....	—	..
Formaldehyde, 40 per cent	lb.	.21½	—	.22½
Glauber's salt (see sodium sulphate)		....	—	....
Glycerine	lb.	.16½	—	.17
Iodine, resublimed	lb.	4.25	—	4.30
Iron oxide, red	lb.	.06	—	.08
Iron sulphate (copperas)	lb.	.01½	—	.02½
Lead acetate, normal	lb.	.12¾	—	.14
Lead arsenate (paste)	lb.	.15	—	.18
Lead nitrate, crystals	lb.	.85	—	.86
Litharge	lb.	.09½	—	.10½
Lithium carbonate	lb.	1.50	—	.....
Magnesium carbonate, technical	lb.	.12	—	.14
Magnesium sulphate, U. S. P.	100 lb.	2.25	—	2.50
Magnesium sulphate, commercial	100 lb.	2.25	—	2.50
Nickel salt, double	lb.	.13	—	.15
Nickel salt, single	lb.	.11½	—	.14
Phosgene (see carbonyl chloride)		....	—	....
Phosphorus, red	lb.	.75	—	.80
Phosphorus, yellow	lb.	.35	—	.40
Potassium bichromate	lb.	.33	—	.35
Potassium, bitartrate, (cream of Tartar)	lb.	.55	—	.58
Potassium bromide, granular	lb.	.49	—	.50
Potassium carbonate, U. S. P.	lb.	.65	—	.70
Potassium carbonate, crude	lb.	.08	—	.14
Potassium chlorate, crystals	lb.	.35	—	.40
Potassium cyanide, 98-99 per cent	lb.	Nominal		
Potassium hydroxide, (caustic potash)	lb.	.35	—	.45
Potassium iodide	lb.	3.30	—	3.40
Potassium nitrate	lb.	.19	—	.22
Potassium permanganate	lb.	.60	—	.75
Potassium prussiate, red	lb.	.85	—	.95
Potassium prussiate, yellow	lb.	.34	—	.45
Potassium sulphate	ton	225.00	—	....
Rochelle salts (see sodium potas. tartrate)		....	—	....
Salammoniac, (see ammonium chloride)		....	—	....
Sal soda (see sodium carbonate)		....	—	....
Salt cake (see sodium bisulphate)		....	—	....
Silver cyanide	oz.	1.00	—	..
Silver nitrate	oz.	.63	—	.65½
Soda ash, light	100 lb.	1.50	—	1.55
Soda ash, dense	100 lb.	2.25	—	2.45
Sodium acetate	lb.	.07	—	.07½
Sodium bicarbonate	100 lb.	2.35	—	2.50
Sodium bichromate	lb.	.09	—	.10
Sodium bisulphate, (nitre cake)	ton	12.00	—	14.00
Sodium bisulphite	lb.	.05	—	.07
Sodium borate, (borax)	lb.	.07½	—	.08
Sodium carbonate (sal soda)	100 lb.	1.60	—	2.00
Sodium chlorate	lb.	.15	—	.18
Sodium cyanide	lb.	.30	—	.31
Sodium fluoride	lb.	.14	—	.15
Sodium hydroxide, (caustic soda)	100 lb.	2.50	—	2.65
Sodium molybdate	lb.	2.50	—	...
Sodium nitrate	100 lb.	4.07½	—	...
Sodium nitrite	lb.	.13	—	.14
Sodium peroxide, powdered	lb.	.25	—	.30
Sodium phosphate, dibasic	lb.	.03½	—	.03½
Sodium potassium tartrate (Rochelle salts)	lb.	.43	—	.45½
Sodium prussiate, yellow	lb.	.16¾	—	.22½
Sodium silicate, solution (40 deg.)	lb.	.02	—	.02½
Sodium silicate, solution, (60 deg.)	lb.	.03¾	—	.04½
Sodium sulphate, crystals, (Glauber's salts)	cwt.	1.25	—	1.50
Sodium sulphide, crystal, 60-62 per cent, (conc)	lb.	.04½	—	.05
Sodium sulphite, crystals	lb.	.04	—	.06½
Strontium nitrate, crystals	lb.	.25	—	.30
Sulphur chloride	lb.	.07½	—	.09
Sulphur, crude	ton	35.00	—	37.50
Sulphur dioxide, liquid, cylinders	lb.	.10	—	.12
Sulphur, (sublimed), flowers	100 lb.	3.05	—	3.15
Sulphur, roll, (brimstone)	100 lb.	2.70	—	3.10
Tin bichloride, (stannous)	lb.	.22½	—	.25
Tin oxide	lb.	.63	—	.66
Zinc carbonate, precipitate	lb.	.18	—	.20
Zinc chloride, gran	lb.	.13½	—	.14
Zinc cyanide	lb.	.49	—	.50
Zinc dust	lb.	.12	—	.13
Zinc oxide, dry American	lb.	.09	—	.11½
Zinc sulphate	lb.	.03¾	—	.04

Coal Tar Products—Intermediates, etc.

NOTE—The following prices are for original packages in large quantities:

Alpha naphthol, crude	lb.	1.00	—	1.10
Alpha naphthol, refined	lb.	1.40	—	1.50
Alpha naphthylamine	lb.	.40	—	.50
Aniline oil, drums extra	lb.	.22	—	.24
Aniline salts	lb.	.28	—	.33
Anthracene, 80% in drums (100 lb.)	lb.	.90	—	1.00
Benzaldehyde (f.f.c.)	lb.	1.30	—	1.50
Benzidine, base	lb.	1.00	—	1.15
Benzidine, sulphate	lb.	.90	—	1.10
Benzoic acid, U. S. P.	lb.	1.00	—	1.25
Benzoate of soda, U. S. P.	lb.	1.00	—	1.25
Benzol, pure, water-white, in drums (100 lb.)	gal.	.22	—	.27
Benzol, 90%, in drums (100 lb.)	gal.	.22	—	.27
Benzyl chloride, 95-97%, refined	lb.	.35	—	.40
Benzyl chloride, tech	lb.	.25	—	.35
Beta naphthol benzoate	lb.	5.50	—	6.00
Beta naphthol, sublimed	lb.	.60	—	.75
Beta naphthol, tech	lb.	.50	—	.55
Beta naphthylamine, sublimed	lb.	2.25	—	2.35
Cresol, U. S. P., in drums (100 lb.)	lb.	.18	—	......
Ortho-cresol, in drums (100 lb.)	lb.	.23	—	.25
Cresylic acid, 97-99%, straw color, in drums	gal.	1.00	—	1.02
Cresylic acid, 95-97%, dark, in drums	gal.	.90	—	.92
Cresylic acid, 50%, first quality, drums	gal.	.60	—	......
Dichlorbenzol	lb.	.07	—	.10
Diethylaniline	lb.	2.25	—	2.50
Dimethylaniline	lb.	.50	—	.57
Dinitrobenzol	lb.	.25	—	.35
Dinitrochlorbenzol	lb.	.25	—	.28
Dinitronaphthaline	lb.	.45	—	.55
Dinitrotoluol	lb.	.38	—	.45
Dinitrophenol	lb.	.30	—	.32
Dip oil, 25% tar acids, car lots, in drums	gal.	.38	—	.46
Diphenylamine	lb.	.70	—	.75
H-acid	lb.	1.90	—	2.25
Metaphenylenediamine	lb.	1.80	—	...
Monochlorbenzol	lb.	.12	—	.14
Monoethylaniline	lb.	1.50	—	1.75
Naphthaline, crushed in bbls. (250 lb.)	lb.	.06	—	.08
Naphthaline, flake	lb.	.07	—	.08
Naphthaline, balls	lb.	.10½	—	.11½
Naphthionic acid, crude	lb.	1.00	—	1.25
Nitrobenzol	lb.	.13	—	.15
Nitro-naphthaline	lb.	.40	—	.45
Nitro-toluol	lb.	.17	—	.20
Ortho-amidophenol	lb.	6.00	—	....
Ortho-dichlor-benzol	lb.	.15	—	.20
Ortho-nitro-phenol	lb.	1.25	—	....
Ortho-toluidine	lb.	.40	—	.45
Ortho-nitro-toluol	lb.	.35	—	.50
Para-amidophenol, base	lb.	2.75	—	3.50
Para-amidophenol, H. Cl.	lb.	3.00	—	3.25
Para-dichlor-benzol	lb.	.06	—	.10
Paranitraniline	lb.	1.10	—	1.25
Para-nitro-toluol	lb.	1.35	—	1.50
Paraphenylenediamine	lb.	3.00	—	3.25
Para toluidine	lb.	1.50	—	1.75
Phthalic anhydride	lb.	1.75	—	2.15
Phenol, U. S. P. drums (dest.), (240 lb.)	lb.	.08	—	.09
Pyridin	gal.	$2.50	—	......
Resorcin, technical	lb.	3.50	—	3.75
Resorcin, pure	lb.	6.75	—	7.00
Salicylic acid, tech., in bbls. (110 lb.)	lb.	.20	—	.30
Salicylic acid, U. S. P.	lb.	.25	—	.35
Salol	lb.	.75	—	.85
Solvent naphtha, water white, in drums, 100 gal.	gal.	.20	—	.25
Solvent naphtha, crude, heavy, in drums, 100 gal.	gal.	.18	—	.20
Sulphanilic acid, crude	lb.	.25	—	.30
Tolidine	lb.	2.25	—	2.50
Toluidine, mixed.	lb.	.45	—	.80
Toluol, in tank cars	gal.	.22	—	.24
Toluol, in drums	gal.	.23	—	.30
Xylidine, drums, 100 gal	lb.	.40	—	.45
Xylol, pure, in drums	gal.	.37	—	.45
Xylol, pure, in tank cars	gal.	.35	—	......
Xylol, commercial, in drums, 100 gal	gal.	.30	—	.40
Xylol, commercial, in tank cars	gal.	.30	—	......

Waxes

Prices based on original packages in large quantities.

Beeswax, natural crude, yellow	lb.	.36	—	.40
Beeswax, refined, yellow	lb.	.42	—	.47
Beeswax, white pure	lb.	.62	—	.65
Carnauba, No. 1	lb.	.80	—	.83
Carnauba, No. 2, regular	lb.	.65	—	.72
Carnauba, No. 2, North Country	lb.	.50	—	.55
Carnauba, No. 3, North Country	lb.	.42	—	.44
Ceresin, yellow	lb.	.16	—	.18
Ceresin, white	lb.	.18	—	.20
Japan	lb.	.15	—	.16
Paraffine waxes, crude match wax (white) 105-110 m.p.	lb.	.07	—	.08
Paraffine waxes, crude scale, 117-119 m.p.	lb.	.07	—	.08
Paraffine waxes, crude scale, 124-126 m.p.	lb.	.07½	—	.08
Paraffine waxes, refined, 118-120 m.p.	lb.	.09	—	.09½
Paraffine waxes, refined, 123-125 m.p.	lb.	.09½	—	.10
Paraffine waxes, refined, 128-130 m.p.	lb.	.09½	—	.10½
Paraffine waxes, refined, 130-132 m.p.	lb.	.10½	—	.11
Paraffine waxes, refined, 133-135 m.p.	lb.	.11½	—	.12
Paraffine waxes, refined, 135-137 m.p.	lb.	.12½	—	.13
Stearic acid, single pressed	lb.	.17	—	.18
Stearic acid, double pressed	lb.	.18	—	.19
Stearic acid, triple pressed	lb.	.20	—	.22
Spermaceti	lb.	.30	—	.32

Flotation Oils

All prices are f.o.b. New York, unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lbs.

Pine oil, steam dist., sp. gr., 0.930-0.940	gal.	$0.68
Pine tar oil, ref., sp. gr. 1.025-1.035	gal.	.45
Pine tar oil, ref., sp. gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla.	gal.	.33
Pine tar oil, double ref., sp. gr. 0.965-0.990	gal.	.58
Pine tar, ref., thin, sp. gr., 1.080-1.960	gal.	.38
Turpentine, crude, sp. gr., 0.900-0.970	gal.	.61
Hardwood oil, f.o.b. Mich., sp. gr., 0.960-0.990	gal.	.24
Hardwood oil, f.o.b. Mich., sp. gr., 1.06-1.08	gal.	.24
Pinewood creosote, ref.	gal.	.48

Naval Stores

The following prices are F.o.b., New York, for carload lots.

Rosin B-D, bbl	280 lb.	$12.20	—	$12.55
Rosin E-I	280 lb.	12.50	—	12.75
Rosin K-N	280 lb.	14.25	—	14.75
Rosin W. G.-W. W	280 lb.	15.25	—	15.60
Wood rosin, bbl	280 lb.	12.25	—	......
Spirits of Turpentine	gal.	.78	—	.78½
Wood Turpentine, steam dist	gal.	.73½	—	......
Wood Turpentine, dest. dist	gal.	.67½	—	......
Pine tar pitch, bbls	200 lb.	8.00	—	8.25
Tar, kiln burned, bbl. (500 lbs.)	bbl.	12.50	—	13.50
Retort tar, bbl	280 lb.	13.50	—	14.50
Rosin oil, first run	gal.	.68	—	.78
Rosin oil, second run	gal.	.70	—	.80
Rosin oil, third run	gal.	.82	—	.83
Rosin oil, fourth run	gal.	.85	—	.95

Solvents

73-76 deg., steel bbls. (85 lb.)	gal.	$0.33½
70-72 deg., steel bbls. (85 lb.)	gal.	.31½
68-70 deg., steel bbls. (85 lb.)	gal.	.30½
V. M. and P. naphtha, steel bbls. (85 lb.)	gal.	.23½

Oils

VEGETABLE

Unless otherwise noted, the following prices are f.o.b., New York.

Castor oil, No. 3, in bbls	lb.	$0.21	—	$0.23
Castor oil, AA, in bbls	lb.	.24	—	.24½
China wood oil, in bbls	lb.	.17	—	.18½
Cocoanut oil, Ceylon grade, in bbls	lb.	.15	—	.15½
Cocoanut oil, Cochin grade, in bbls	lb.	.16½	—	.17
Corn oil, crude, in bbls	lb.	.18	—	.19
Cottonseed oil, crude (f.o.b. mill)	lb.	.17½	—	......
Cottonseed oil, summer yellow	gal.	.22	—	.22½
Cottonseed oil, winter yellow	gal.	.23½	—	....
Linseed oil, raw, car lots	gal.	1.56	—	1.58
Linseed oil, raw, tank cars	gal.	1.52	—	1.56
Linseed oil, boiled, car lots	gal.	1.58	—	1.60
Olive oil, commercial	gal.	2.10	—	2.25
Palm, Lagos	lb.	.15½	—	.18
Palm, bright red	lb.	.15	—	.16
Palm, Niger	lb.	.14	—	.15
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.18	—	.19½
Peanut oil, refined, in bbls	lb.	.22	—	.23
Rapeseed oil, refined, in bbls	gal.	1.50	—	1.55
Rapeseed oil, blown, in bbls	gal.	1.58	—	1.60
Soya bean oil (Manchurian), in bbls., N. Y	lb.	.16	—	.16½
Soya bean oil, tank cars, f.o.b., Pacific coast	lb.	.14½	—	.15

FISH

Winter pressed Menhaden	gal.	$0.85
Yellow bleached Menhaden	gal.	.87
White bleached Menhaden	gal.	.89
Blown Menhaden	gal.	.95

Miscellaneous Materials

All Prices F.o.b., N. Y.

Barytes, domestic, white, floated	ton	$25.00	—	$36.00
Barytes, off color	ton	22.00	—	27.00
Blanc fixe, dry	lb.	.03½	—	.04½
Blanc fixe, pulp	ton	30.00	—	45.00
Casein	lb.	.17	—	.19
Chalk, English, extra light	lb.	.05	—	.07
Chalk, English, light	lb.	.04½	—	.06
Chalk, English, dense	lb.	.04	—	.05
China clay (Kaolin), imported, lump	ton	35.00	—	......
China clay (Kaolin), imported, powdered	ton	60.00	—	......
China clay (Kaolin), domestic, lump	ton	10.00	—	20.00
China clay (Kaolin), domestic, powdered	ton	25.00	—	40.00
Feldspar	ton	11.00	—	15.00
Fluorspar, acid grade, lump, f.o.b. mines	net ton	35.00	—	37.00
Fluorspar, acid grade, ground, f.o.b. mines	net ton	40.00	—	45.00
Fuller's earth, domestic, powdered	ton	30.00	—	40.00
Fuller's earth, imported, powdered	ton	.....	—	....
Pumice stone, imported	lb.	.03	—	.06
Pumice stone, domestic	lb.	.02½	—	....
Shellac, TN	lb.	.60	—	....
Shellac, D.C.	lb.	.75	—	....
Shellac, V. S. O.	lb.	.75	—	.80
Shellac, Diamond I	lb.	.75	—	....
Shellac, orange, fine	lb.	.65	—	....
Shellac, orange, superfine	lb.	.67	—	....
Shellac, A.C. garnet	lb.	.60	—	....
Shellac, bleached, bone dry	lb.	.67	—	....
Shellac, bleached, fresh ground	lb.	.57	—	
Soapstone	ton	15.00	—	25.00
Talc, domestic	ton	16.00	—	60.00
Talc, imported	ton	55.00	—	60.00

Refractories

Following prices are f. o. b. works:

Chrome brick	net ton	90-100 at Chester, Penn.
Chrome cement	net ton	45-50 at Chester, Penn.
Clay brick, 1st quality fireclay	net ton	35-45 at Clearfield, Penn.
Clay brick, 2nd quality	net ton	30-35 at Clearfield, Penn.
Magnesite, dead burned	net ton	50-55 at Chester, Penn.
Magnesite brick, 9 x 4½ x 2½ in.	net ton	80-90 at Chester, Penn.
Silica brick	net ton	41-45 at Mt. Union, Penn.

Ferro-alloys

All prices f. o. b. works.

Ferro-chrome, per lb. of Cr. contained, 6-8% carbon	lb.	.32	—	.40
Ferro-chrome, per lb. of Cr. contained, 2-4% carbon	lb.	.70	—	.....
Ferro-manganese, 70-80% Mn	gross ton	110.00	—	150.00
Spiegeleisen, 16-20% Mn	gross ton	40.00	—	50.00
Ferro-molybdenum, per lb. of Mo	lb.	2.50	—	3.00
Ferro-silicon, 50%	gross ton	90.00	—	115.00
Ferro-silicon, 75%	gross ton	150.00	—	175.00
Ferro-silicon, 10-15%	gross ton	50.00	—	60.00
Ferro-tungsten, 70-80%, per lb. of contained W	lb.	1.30	—	1.60
Ferro-uranium, 35-50%, of U	lb.	7.00	—	.....
Ferro-vanadium, 30-40%, per lb. of contained V.	lb.	5.50	—	7.00

Resales and overstocks make above prices approximate.

Ores and Semi-finished Products

Chrome ore, 35-40%, Cr_2O_3	unit	$0.70		
Chrome ore, 48% and over	unit	1.00	—	$1.25
Coke, foundry, f.o.b. mines	net ton	4.50	—	5.00
Coke, furnace, f.o.b. mines	net ton	3.75	—	4.75
Petroleum coke, f.o.b. Atlantic seaboard	net ton	16.00	—	16.50
Fluorspar, gravel, f.o.b. mines	net ton	18.50	—	20.00
Manganese ore, 45% Mn and over	unit	.50	—	.85
Manganese ore, chemical (MnO_2)	gross ton	60.00	—	70.00
Molybdenite, 85% MoS_2, per lb. of MoS_2	lb.	.75	—	.85
Tungsten, Scheelite, 60% WO_3 and over per unit of WO_3	unit	9.00	—	10.00
Tungsten, Wolframite, 60% WO_3 and over, per unit of WO_3	unit	6.50	—	8.00
Uranium oxide, 96%	lb.	......	—	......
Vanadium pentoxide, 99%	lb.	6.00	—	......
Pyrites, foreign, lump	unit	.17	—	......
Pyrites, foreign, fine	unit	.17	—	......
Pyrites, domestic, fine	unit	.14	—	......
Ilmenite, 50% TiO_2	net ton	30.00	—	......
Rutile, 95% TiO_2	net ton	200.00	—	......
Carnotite, minimum 2% U_3O_8, per lb. of U_3O_8	lb.	3.00	—	3.25

Resales and overstocks make above prices approximate.

Plant Materials and Supplies

In carload lots, New York, unless otherwise stated.

BUILDING MATERIALS

Portland cement, at dock, without bags	bbl.	$2.30
Lump lime, common, including container 300	bbl.	2.65
Common brick, at dock	M.	15.00
Hollow building tile, At factory, Perth Amboy, N. J., 8x12x12	M.	194.40
Hollow building tile, At factory, Perth Amboy, N. J., 12x12x12	M.	291.60
Yellow pine, 3x4 to 8x8, 20-24 ft. long	M.	39.00
Yellow pine, 3x4 to 8x8, .0- 4 ft. long at Chicago	M.	38.50
Yellow pine, 3x4 to 8x8, 20-24 ft. long at St. Louis	M.	35.00
Roofings, tar felt (14 lb. per 100 sq.ft.)	ton	50.00
Roofings, tar pitch (in 400-lb. bbl.)	ton	19.00
Roofings, asphalt pitch	ton	30.00
Roofings, asphalt felt	ton	65.00
Roofings, slate-surfaced shingles, per roll of 108 sq.ft.		2.10
Roofings, slate-finished shingles, 100 sq.ft.		5.50
Linseed oil, raw in barrels	gal.	$1.63
Linseed oil, 5 gal. cans	gal.	1.76
Red lead, dry, 100 lb. keg	lb.	.13
Red lead, in oil, 100 lb. keg	lb.	.14½
Red lead, dry, 5 lb. cans	lb.	.15
Red lead, in oil, 5 lb. cans	lb.	.16½
White lead, dry and in oil, 100 lb. keg	lb.	.13
White lead, dry and in oil, 25 and 50 lb. kegs	lb.	.13½
White lead, dry and in oil, 5 lb. cans	lb.	.15

STRUCTURAL STEEL, MILL, PITTSBURGH

Beams and channels, 3 to 15-in.	100 lb.	$2.45
Angles, 3 to 6-in., ¼-in. thick	100 lb.	2.45
Tees, 3-in. and larger	100 lb.	2.45
Plates	100 lb.	2.66
Rivets, structural, ¾-in. and larger	100 lb.	4.20
Rivets, conehead for boilers, ¾-in. and larger	100 lb.	4.30
Sheets, No. 28 black	100 lb.	4.35
Sheets, No. 10 blue annealed	100 lb.	3.55
Sheets, No. 28 galvanized	100 lb.	5.70

For painted corrugated sheets, add 30c. per 100 lb. for 25 to 28 gage; 25c. for 19 to 24 gage; for galvanized corrugated sheets, add 15c., all gages.

INDUSTRIAL

Financial, Construction and Manufacturers' News

Construction and Operation

Arizona

AJO—S. Clark plans to build a leaching plant having a daily capacity of 50 tons at Clarkston, near here. Estimated cost, $10,000.

DUNCAN—The Goldfield Consolidated Mining Co., Reno, Nev., plans to build a 100-ton mill and cyanide plant at Ash Peak, here. C. Storr, superintendent.

GLOBE—The Gila Monster Co. plans to build a 10-stamp mill and a cyanide plant. W. H. Seaman, superintendent.

MORENCI — The Phelps-Dodge Corp., Bisbee, plans to either remodel its old plant here or build a new modern plant. M. H. McLean, mine superintendent.

MORENCI—The Stargo Syndicate plans to build a mill and a 100-ton cyanide plant. M. J. Hannon, superintendent. J. M. Callow, Salt Lake City, Utah, consulting engineer.

TUCSON—The Mineral Hills Co. plans to build a concentrator. Estimated cost, $100,000. U. A. Fritschie, manager.

California

CULVER CITY—The H. Lehrman Studios have awarded the contract for the construction of a film manufacturing plant, to the Milwaukee Building Co., 316 Wright & Callender Bldg., Los Angeles. Estimated cost, $75,000.

MODESTO—The Modesto Gas Co. plans to build a 300,000-cu.ft. steel gas holder and extend the gas mains to new sections of the city, also to build a new gas generating unit and install two purifiers. Estimated cost, $65,000.

Colorado

BOULDER—The city plans to build a filtration plant. Estimated cost, $150,000. W. D. Salter, city engineer.

VANADIUM—The Primos Chemical Co. plans to build a treatment plant for the reduction and concentration of vanadium ores, and is in the market for lumber, metal work, crushing machinery, tanks, screens, motors, belting, etc. Estimated cost, $75,000.

Florida

WINTER GARDEN—The city plans an election June 15 to vote on $75,000 bonds for water, light and sewer improvements. Plans include the construction of a septic tank and disposal plant. W. H. Reams, mayor.

Georgia

LA GRANGE—G. H. Sargent, city engineer, will soon receive bids for the construction of a sewage disposal plant. C. L. Smith, clerk and treasurer.

Idaho

NAMPA—The city plans to extend the sewerage system and build a septic tank. Estimated cost, $80,000.

Illinois

CHICAGO—Foley & Co., 2835 Sheffield Ave., manufacturer of proprietary medicines, plans to build a 2-story addition to its existing plant, also a new 5-story, 40 x 125-ft. building. Estiamted cost, $200,000. E. R. Krause, Majestic Theater Bldg., architect.

CHICAGO—The Municipal Tuberculosis Sanitarium, Crawford and Bryn Mawr Aves., has awarded the contract for the construction of a 2-story, 57 x 123-ft. laboratory, to H. F. Friestedt Co., 327 La Salle St. Estimated cost, $75,000. Noted Mar. 15.

JACKSONVILLE—The city voted $75,000 bonds for the construction of a dam and filtration plant. E. M. Henderson, city engineer.

MADISON—The Barber Asphalt Co., Land Title Bldg., Philadelphia, Pa., plans to build a refinery here. A. L. Robinson, c/o owner, chief engineer.

WHEATON—The State Board of Health, Springfield, has approved plans for the construction of a sewage disposal plant. L. Ruddock, city engineer.

Indiana

INDIANAPOLIS—The Hook Drug Co. has awarded the contract for the construction of a 3-story building on Market and Noble Sts., to R. Baumann. Estimated cost, $18,000. Plans include the installation of laboratories, etc.

NEW ALBANY—The Calumet Fertilizer Co. plans to build an acidulating plant for the treatment of commercial fertilizers. Estimated cost, $100,000. O. Voyles, manager.

Iowa

COUNCIL BLUFFS — The city has awarded the contract for the construction of a garbage incinerator, to the Jones Garbage Crematory Co., St. Louis, Mo. Estimated cost, $16,200. C. O. Frazer, city clerk.

FAIRPORT—The Commissioner of Fisheries, Department of Commerce, Washington, D. C., will receive bids until May 26 for the construction of a laboratory building at the Biological Station, here.

WILLIAMSBURG—The city has awarded the contract for the construction of a disposal plant to Ward & Weighton, 516-517 Davidson Bldg., Sioux City. Estimated cost, $12,500. E. Lewis, city clerk.

Kansas

TOPEKA—W. L. Johnson, c/o the Wolff Packing Co., foot of Quincy St., plans to build a 1-story, 44 x 54-ft. serum plant and a 1-story, 50 x 96-ft. hog shed on Jefferson and Crane Sts. Estimated cost, $15,000. C. D. Cuthbert, 736 Kansas Ave., architect.

TREECE—The Wachusetts Mining Co., Commeree, Okla., plans to install a hand jig plant and is in the market for several hand jigs. A. Mayerhoff, manager.

Kentucky

ASHLAND—The city is having plans prepared by Alvord & Burdick, engineers, 8 South Dearborn St., Chicago, Ill., for the construction of a filtration plant having a capacity of 2,000,000 gallons. E. C. Means is chairman of the water commissioners.

LOUISVILLE—The Louisville Cotton Seed Oil Co., 1318 McHenry St., plans to rebuild its plant recently destroyed by fire, entailing a loss of $500,000.

Maryland

BALTIMORE—The State Department of Health will alter the bacteriological laboratory at 14 West Saratoga St. Address R. B. Morse, on premises.

BALTIMORE—The H. S. Wampole Co., 761 Columbus Ave., received bids for building an addition to its proprietary medicine plant on Barre and St. Peter Sts., from the B. F. Bennett Building Co., 123 South Howard St.; G. W. Tovell, Eutaw and McCullough Sts.; Rhodes & Billops, 611 Haywood St., Arlington. Estimated cost, $35,000.

HAGERSTOWN—Shaffer & Locke, 684 Pennsylvania Ave., plan to install an acetylene welding plant for aluminium, brass, copper, etc.

HANCOCK—The Maryland Glass Sand Co., Hagerstown, is building a plant at Round Top, near here, to have a yearly capacity of 60,000 tons. Estimated cost, $50,000. E. W. Funkhouse, secretary.

HIGHLANDTOWN (Baltimore P. O.)—Jones & Lamb Co., Pennsylvania and Fulton Aves., Baltimore, plans to convert the plant of the Monumental Brewery Co., on Lombard St., into a meat packing plant and oil refinery; also construct several new buildings. Estimated cost, $500,000. C. B. Comstock, 110 West 40th St., New York City, engineer.

HOMEWOOD (Baltimore P. O.)—The trustees of Johns Hopkins University received bids for the construction of a 1-story, 50 x 150-ft. laboratory, from the Consolidated Engineering Co., 243 Calvert Bldg., B. F. Bennett Building Co., 123 South Howard St.; Frainie Bros. & Haigley, 18 Clay St. Estimated cost, $50,000. Equipment for electro-chemistry and metallurgical chemistry laboratories, also for physical, organic and inorganic chemistry study and experimentation will be installed in same. F. J. Goodnow, president.

Massachusetts

CHATHAM—The Bureau of Yards & Docks, Navy Department, Washington, D. C., has awarded the contract for the construction of a septic tank and sewage disposal plant, here, to H. S. Roberts, 1123 Broadway, New York City, N. Y. Estimated cost, $40,925 (75 days). Noted April 1.

WILLIMANSETT — The Papermakers' Chemical Co., Main St., Holyoke, plans to build a plant for the manufacture of chemicals necessary to the paper trade and principally for purification of rosins, on Chicopee St., here. Estimated cost, $75,000. R. M. Snell, manager.

Missouri

CAMERON—The city is having plans prepared for the installation of a filtration plant at the waterworks.

ST. LOUIS—The National Barium & Chemical Co., 7338 Arlington Ave., plans to build a chemical plant near Union St. and Natural Bridge Rd. Estimated cost, $50,000. O. Virden, president.

ST. LOUIS—The Parker-Russell Mining & Mfg. Co., Laclede Gas Bldg., plans to rebuild its silica factory at 3300 Morganford Rd., recently destroyed by fire entailing a loss of $20,000. L. Parker, c/o owner, engineer.

Montana

BUTTE—The Trustees of the State School of Mines plan to build a chemical and metallurgical building. Estimated cost, $100,000.

HARDIN—The Board of Education has awarded the contract for the construction of a 3-story high school on 5th St. to the Veatch Co., Billings. Laboratory fixtures and furnishings will be installed in same. Total estimated cost, $53,000.

New Jersey

JERSEY CITY—The city has awarded the contract for building an additional wing at the City Hospital, to W. H. & T. W. Cane, Baldwin Ave. Plans include the installation of a laboratory and fumigation building. Estimated cost, $963,145.

New York

ATHENA—The town is having plans prepared by M. Vrooman, consulting engineer, Gloversville, for the construction of a water system, water filters and a pumping station, also a sewage system and a complete disposal plant.

BROOKLYN—J. Bene & Sons, 641 Dean St., have awarded the contract for the construction of a 2-story, 100 x 100-ft. chemical factory on Carlton St., to the W. Kennedy Construction Co., 215 Montague St. Noted April 1.

BROOKLYN — The Brooklyn Hebrew Home & Hospital for the Aged, Howard and Dumont Ave., plans to build a 4-story, 90 x 100-ft. addition to its home and hospital. A chemical laboratory will be installed in same. Total estimated cost, $100,000. L. Abramson, 220 5th Ave., New York City, architect.

BROOKLYN — The Maternity Hospital Society, 1666 Pitkin Ave., plans to build a 3-story, 50 x 80-ft. hospital on Howard and Dumont Aves. Project includes the installation of a chemical laboratory. Estimated cost, $75,000. Cohn Bros., 361 Stone Ave., architects.

BUFFALO—The Mentholatum Co., 146 Seneca St., has awarded the contract for the construction of a 4-story, 80 x 100-ft. factory to the J. W. Cowper Co., Fidelity Bldg. Estimated cost, $225,000. Noted April 25.

BUFFALO—The U. S. Rubber Reclaiming Co., 784 Babcock St., has awarded the contract for the construction of a 1-story 80 x 150-ft. addition to its factory, to B. I. Crooker, Builders' Exchange. Estimated cost, $10,000.

CARTHAGE—J. Thompson, Carthage, has purchased the property between North Washington and North Clinton Sts., and plans to install sewer service to all lots

on tract, also construct a sewage disposal plant. Estimated cost, $13,500.

LONG ISLAND CITY—The General Chemical Co., 25 Broad St., New York City, has awarded the contract for the construction of a laboratory building on Washington Ave. and Halle St., here, to Leddy & Moore, 105 West 40th St., New York City. Estimated cost, $35,000.

LONG ISLAND CITY—The Liquid Carbonic Co., 624 1st Ave., New York City, has awarded the contract for the construction of a 1-story, 65 x 155-ft. factory and warehouse on Maspeth Ave., between Metropolitan and Grand Aves., to the G. A. Engineering Co., 239 Vernon Ave., Brooklyn. Estimated cost, $35,000.

NEW YORK—G. J. Adams, consulting engineer, 39 South St., is in the market for a Karl Kiefer filter with 22 cells.

NIAGARA FALLS—The Defiance Paper Co., Walnut and 3rd Sts., has awarded the contract for the construction of an addition to its pulp mill on Walnut St. to the J. W. Cowper Co., Fidelity Building, Buffalo. Estimated cost, $25,000. Noted April 15.

ROCHESTER—The city is having plans prepared for the construction of a sewage disposal plant in the 23rd Ward, to include one Imhoff tank and pumping system to care for the territory between Lata Road and Beach Ave.; also one in the Maplewood District, to include sprinkler filters. Address J. F. Skinner, assistant city engineer.

SYRACUSE—The city plans to build a garbage disposal plant. H. C. Allen, city engineer.

WAUSAU—The Chamberlain Paint & Oil Co. plans to build an addition to its present plant and install additional paint grinding and manufacturing machinery.

North Carolina

HIGH POINT—The city has awarded the contract for installing filtering apparatus and filters at the proposed water plant, to R. K. Stewart & Son, Farmville, Va., at $59,930, and the Pittsburg Meter Co., First National Bank Bldg., Pittsburgh, Pa., at $21,400.

Ohio

CLEVELAND—The Foster Manufacturing Co., 2113 East 79th St., has awarded the contract for the construction of a 1-story, 51 x 85-ft. sheet metal factory at 7600 Carnegie Ave., to I. Brygnons, 3505 Woodland Ave. Estimated cost, $6000.

CLEVELAND — The Ko-Ko-Mar Co., Leader-News Bldg., plans to remodel the brewery on West 46th St. and Train Ave. into a food products plant. Estimated cost, $40,000. A. C. Bishop, 427 Guardian Bldg., architect.

DOVER—The Tuscarora Rubber Co., c/o the W. C. Owen Engineering Co., engineers, 1900 Euclid Bldg., Cleveland, plans to build a 3-story rubber factory here.

Oklahoma

DOUTHAT—The Admiralty Zinc Co. plans to install a new sand jig and is in the market for one set of jig irons and one set of chat rolls. W. B. Shackelford, general manager.

DOUTHAT—W. Dudley plans to build a tailing mill to handle sand tailings from Admiralty Mill No. 2 and is in the market for six tables, motor, set rolls and belting.

DUNCAN—The city has awarded the contract for the construction of a sewage disposal plant to L. H. Haas. Estimated cost, $7556.

HENRYETTA—The city voted $310,000 bonds for waterworks improvements, to include the construction of a filtration plant, settling basins, supply line and distribution system. H. M. La Rue, superintendent of water works. Burns & McDonnell, Interstate Bldg., Kansas City, Mo., engineers.

HOCKERVILLE—The Prospectors Mining Co. plans to move its mill from Aurora field and erect same at Hockerville, and is in the market for an engine, boiler, rock drills and tables. W. Crawford, superintendent.

Pennsylvania

PHILADELPHIA—The Liquid Carbonic Co., 3100 South Kedzie Ave., Chicago, Ill., plans to build a 2-story, 60 x 108-ft. factory here. J. J. Novy, 3223 West 22nd St., Chicago, Ill., architect.

South Carolina

COLUMBIA—The Carolina Veneer Co., Tobacco St., plans to rebuild its plant recently destroyed by fire. J. E. Kocha, president and treasurer.

Texas

DALLAS—The Bell & Blake Co., 118 Field St., plans to install two 20-ton Scott furnaces for recovering quicksilver from Cinnabar ores.

LONGVIEW—The Texas Leasing & Development Co., Wichita Falls, plans to build an oil refinery having a daily capacity of 10,000 bbl.

WACO—The Arrow Refining Co., Suite 2010 Amicable Bldg., plans to build an oil refinery having a capacity of 5000 bbl. Estimated cost, $300,000. C. S. Dawley, president.

WICHITA FALLS—The Meridian Gasoline Co., organized by J. F. Darby, 408 New Daniels Bldg., and W. K. Campbell, 1644 South Denver St., both of Tulsa, Okla., and others, plan to build a casing-head gasoline plant here. Estimated cost, $200,000.

WICHITA FALLS—The Texhoma Oil & Refining Co. has acquired the oil refinery of Fisher & Gilliland, and plans to increase the daily capacity of same from 1200 to 2000 bbl.

Virginia

NORFOLK—The Bureau of Yards & Docks, Navy Department, Washington, D. C., has awarded the contract for the construction of galvanizing plant here to the W. Linker Co., 831 Cherry St., Philadelphia, Pa. Estimated cost, $119,000. Noted April 15.

West Virginia

CHARLESTON—J. S. Lakin, of the State Board of Control, will receive bids until May 22 for the construction of a sewage-sedimentation tank, sprinkling filter, sludge bed and chlorinating plant. C. E. Collins, Drexel Bldg., Philadelphia, Pa., consulting engineer.

CLARKSBURG—The Lafayette Glass Co. plans to rebuild its plant recently destroyed by fire, entailing a loss of $300,000.

WHEELING—The city plans an election soon to vote on a bond issue for the construction of a filtration plant, to be series of mechanical rapid rate pumps. Chester & Fleming, Union Bank Bldg., Pittsburgh, Pa., engineers.

British Columbia

ANYOX—The Granby Consolidated Ore Co. plans to build a plant. Estimated cost, $50,000.

VICTORIA—The Department of Mines plans the construction of a building for mineralogical experiments. Estimated cost, $200,000.

Ontario

LARDER LAKE—The Associated Gold Fields of Larder Lake plan to build a mill and are in the market for machinery for the mill and cyanide plant, motors, etc. Estimated cost, $600,000. A. Diampre, superintendent.

Coming Meetings and Events

THE AMERICAN INSTITUTE OF CHEMICAL ENGINEERS will hold its Summer meeting at Boston, Mass., June 18-21. A symposium is planned on electric furnaces.

THE AMERICAN IRON & STEEL INSTITUTE will hold its next meeting on May 23-24 at the Hotel Pennsylvania, New York.

THE AMERICAN SOCIETY FOR TESTING MATERIALS will hold its 22nd annual meeting at Atlantic City, N. J., June 24-27. The headquarters will be at the Hotel Traymore.

THE AMERICAN ZINC INSTITUTE will hold its annual meeting at St. Louis, Mo., June 9-10.

THE FRANKLIN INSTITUTE will hold a meeting on May 21 at which the presentation of the Franklin Medal to Major-General James Douglas McLachlan on behalf of his Britannic Majestiy's Government for Sir James Dewar will be given, together with the presentation of the Franklin Medal to Major-General George Owen Squier of the United States Army.

THE NATIONAL FERTILIZER ASSOCIATION will hold its 26th annual convention the week of June 23 at the Hotel Griswold, Eastern Point, New London, Conn.

THE TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY will hold its Spring meeting, June 11-14 inclusive.

Industrial Notes

THE CHEMICAL FOUNDATION, INC., which was organized at the suggestion of the Alien Property Custodian for the purpose of purchasing and exploiting chemical patents and trade marks previously owned by Teutonic interests in this country, has leased the entire fourth floor from the Irving Trust Co. at 81-83 Fulton St., for a long term of years. The new headquarters of the Foundation will be made a center for research for the advancement of chemistry and its allied sciences and their application to manufacturing purposes in the United States.

KARL S. REINHARDT announces the removal of his office from 1210 Yeon Bldg. to the Worcester Bldg., Portland, Ore.

THE HOHMANN-NELSON CO. has been organized at Eau Claire, Wis., for the manufacture of temperature, pressure, time and level controllers and recording thermometers and gages for industrial processes. The officers of the company are A. B. Hohmann, president, A. J. Nelson, vice-president and secretary, and Edward Hutchens, treasurer.

THE STEPHENS-ADAMSON MFG. CO., Aurora, Ill., has appointed Fred W. Wells as assistant engineer of the New York district office. Mr. Wells was associated with this company prior to his entering the service early in the year 1918. He was appointed first lieutenant in the 26th Engineers, served in various sections of France and with the first army during the Argonne-Meuse operation.

THE TALC PRODUCTS CO., INC., has been formed by a group of Los Angeles men with offices in the Washington Bldg., Los Angeles, Cal., to engage in the manufacture of metal-workers' crayons from white rock talc. Mr. H. N. Thomson is president of the company.

THE BROWN CO., Portland, Me., has been granted a writ of certiorari by the U. S. Supreme Court in the so-called hydrogenated oil case. This litigation, which is to determine the scope or validity of the Burchenal patent, owned by Procter & Gamble, has so far resulted in a decision for the defendant in the District Court and a reversal in the Appellate Division. The Supreme Court will now pass upon the question, which is said to be the first patent case of the kind to come before them.

THE AMERICAN STEAM CONVEYOR CORP., Chicago, Ill., announces the appointment of Mr. N. B. Stewart as district representative in charge of its St. Louis territory. Offices have been opened at 708 Merchants-LaClede Bldg., St. Louis, Mo.

THE COMMERCIAL ELECTROLYTIC CORP., New York City, announces the removal of offices from 55 Liberty St. to 527 Fifth Avenue.

THE TECHNICAL PRODUCTS CO., INC., and the HERCULES ENGINEERING CORP., of 501 Fifth Ave., New York, announce the appointment of Mr. A. B. Curtis, Jr., as Western manager with headquarters at 728 Monadnock Bldg., Chicago, Ill.

THE NEW JERSEY ZINC CO. announces the appointment of Mr. E. V. Peters to succeed Mr. H. C. Clopper as head of the sales department.

THE LUNKENHEIMER CO. announces that after May 1, 1919, the New York branch will be located at 129-135 Lafayette St.

THE NATIONAL BANK OF COMMERCE IN NEW YORK has opened an office in London, at 17 Sherborne Lane, King William St. Mr. Kenneth H. Rockey is in charge.

THE AMERICAN ZINC, LEAD & SMELTING CO., with offices in St. Louis, New York and Boston, has arranged with the American Zinc Sales Co. to handle the Azo zinc oxide in Chicago and adjacent territory. The latter company has offices at 1415 Conway Bldg. under the management of Mr. A. C. Eide. Mr. Eide previously had an active part in the technical development of processes for the manufacture of zinc oxide.

THE JOSEPH DIXON CRUCIBLE CO., Jersey City, N. J., held a meeting on April 21 at which the following officers were elected: President, George T. Smith; vice-president, J. H. Schermerhorn; secretary, Harry Dailey; treasurer, William Koester; assistant secretary and assistant treasurer, Albert Norris. Announcement is made of the removal of the Philadelphia sales office of the company from 1020 Arch St. to Rooms 801-802, Finance Bldg. This office is under the direction of Mr. W. G. Stringer.

THE CELITE PRODUCTS CO. announces the appointment of Mr. Frank Bethune, 808 Perdido St., New Orleans, La., as repre-

sentative for the Louisiana and Mississippi district. A warehouse stock will be carried to insure prompt deliveries of Sil-O-Cel brick, powder and cement for insulation, also Filter-Cel for filtration. Mr. Ward D. Dygert has been appointed Detroit representative with headquarters in the Book Bldg.

THE FRENCH & AMERICAN BANKING CORP., representing an alliance of French and American banking interests with combined resources of over one and a quarter billion dollars, has been incorporated to promote trade between France and the United States. The incorporators are James S. Alexander, president of the First National Bank of Boston; Maurice Silvester, American representative of the Comptoir National d'Escompte de Paris, and others. Mr. Silvester will be president of the new company. There will be twelve directors, six to represent the American group and six the French group.

THE AMERICAN CHAMBER OF COMMERCE IN LONDON announces the appointment of Mr. George P. Toby as executive secretary. Mr. Toby spent over a year in Washington on plans for co-operation between the various Government departments and the business world. His work as investment banker has also given him knowledge of commercial possibilities that will be of value to American manufacturers who desire to engage in export trade. It is desired that the American manufacturers, merchants and exporters should learn to look upon the American Chamber of Commerce in London as an overseas service bureau to promote American business.

THE WILKENS & ANDERSON CO. announces the new location of general offices at 213-215 Desplaines St., Chicago, Ill.

New Publications

DESIGN OF CONCRETE MIXTURES. By Duff A. Abrams. Published by the Structural Materials Research Laboratory, Lewis Institute, Chicago, Ill.

TUNGSTEN, CINNABAR, MANGANESE, MOLYBDENUM, AND TIN DEPOSITS OF IDAHO. By D. C. Livingston, with notes on the antimony deposits, by Francis A. Thomson. University of Idaho, School of Mines Bull. No. 2, Vol. XIV.

ANALYSIS AND TESTS OF RIGIDLY CONNECTED REINFORCED CONCRETE FRAMES. By Mikishi Abe. Bull. No. 107, Engineering Experiment Station; The College of Engineering and Engineering Experiment Station, a pictorial description; A Discussion of the Development and Needs of the College of Engineering and the Engineering Experiment Station of the University of Illinois, Vol. XVI, No. 12. The above are published by the University of Illinois, Urbana, Ill.

A SUMMARY OF MINING IN THE STATE OF WASHINGTON. By Arthur Homes Fischer. Engineering Experiment Station Series, Bull. No. 4, published by the University of Washington, Seattle, Wash.

BIENNIAL REPORT OF THE STATE GEOLOGIST, 1917-1918. Published by the North Carolina Geological and Economic Survey, Raleigh, N. C.

COMMERCE MONTHLY is the title of a booklet on commerce and finance, the initial issue of which has just been published by the National Bank of Commerce in New York. The purpose of the magazine is "to serve as a medium through which the experience and investigations that have proved useful to this bank in the fields of industry, commerce and finance may be shared with its friends." It is announced that the table of wholesale commodities prices, the money market and the market letter will be regular features of the publication.

NEW BUREAU OF STANDARDS PUBLICATIONS: Circ. 24, entitled "Publications of the Bureau of Standards," 5th edition, issued April 14, 1919. This circular gives titles of all four series—scientific papers, technologic papers, circulars and miscellaneous publications. The list is numerically arranged in each series and each title is accompanied by an abstract. A full index facilitates reference to publications on specific subjects; Circ. No. 77. Table of Unit Displacement of Commodities. Issued Mar. 10, 1919; Circ. No. 79. Electrical Characteristics and Testing of Dry Cells, issued April 25, 1919; Special Agent Series No. 175 is on Construction Materials and Machinery in South American Countries. The pamphlet has been prepared to give information regarding the requirement for all kinds of construction material and machinery in Chile, Peru and Ecuador. Copies are obtainable from the Supt. of Documents, Government Printing Office, Washington, D. C., at 20c. each.

THE U. S. DEPARTMENT OF LABOR, U. S. TRAINING SERVICE. Bull. No. 7 on Industrial Training and Foreign Trade; Bull. No. 6, Labor Turnover and Industrial Training.

THE FEDERAL BOARD FOR VOCATIONAL EDUCATION has issued a series of Opportunity Monographs. Series No. 23, Commercial Occupations; Series No. 25, Occupations in the Electrical Manufacturing Industries; Series No. 22, Teaching as a Vocation; Series No. 21, Farm Management as a Vocation; Series No. 29, Occupations in the Automobile Manufacturing Industry; Series No. 19, The Lumber Industry and No. 18, Journalism as a Vocation.

NEW UNITED STATES GEOLOGICAL SURVEY PUBLICATIONS: I:18, Gold, Silver, Copper, Lead and Zinc in Idaho and Washington in 1917, Mines Report. By C. N. Gerry (Mineral Resources, 1917, Part I), published April 3, 1919; I:19, Gold, Silver, Copper, Lead and Zinc in Arizona in 1917, Mines Report. By V. C. Heikes (Mineral Resources, 1917, Part I), published April 1, 1919; I:17, Quicksilver in 1917. By F. L. Ransome, with a Bibliography. By I. P. Evans (Mineral Resources, 1917, Part I), published March 18, 1919; II:27, Mineral Water in 1917. By Arthur J. Ellis (Mineral Resources, 1917, Part II), published April 21, 1919; I:20, Iron Ore, Pig Iron and Steel in 1917. By Ernest F. Burchard (Mineral Resources, 1917, Part I), published April 2, 1919; II:I, Fuel Briquetting in 1918. By C. E. Lesher (Mineral Resources, 1918, Part II), published April 30, 1919.

NEW U. S. TARIFF COMMISSION PUBLICATIONS: Japan—Trade During the War and Costs of Production in the Sugar Industry.

NEW BUREAU OF MINES PUBLICATIONS: Bull. 166, A Preliminary Report on the Mining Districts of Idaho. By Thomas Varley, Clarence A. Wright, Edgar K. Soper and Douglas C. Livingston; Bull. 169, Illinois Mining Statutes Annotated. By J. W. Thompson, including Illinois Mining Laws; Tech. Paper 178, Notes on Lignite, Its Characteristics and Utilization. By S. M. Darling; Tech. Paper 207, Combustion Experiments with North Dakota Lignite. By Henry Greisinger, C. E. Augustine and W. C. Harpster; Tech. Paper 209, Traps for Saving Gas at Oil Wells. By W. R. Hamilton; Tech. Paper 213, Quarry Accidents in the United States During the Calendar Year 1917. Compiled by Albert H. Fay; Tech. Paper 218, Boiler Water Treatment. Reprint of Engineering Bull. No. 3, prepared by the U. S. Fuel Administration in collaboration with the Bureau of Mines; Tech. Paper 219, Combustion and Flue Gas Analysis. Reprint of Engineering Bull. No. 4, prepared by the U. S. Fuel Administration.

Manufacturers' Catalogs

THE FOAMITE FIREFOAM CO., New York City, has issued a catalog entitled "60 Seconds—And Out!" which illustrates and describes the use of Foamite Firefoam for putting out fires at oil plants, garages, etc.

THE WILL CORPORATION, Rochester, N. Y., has published a complete catalog of laboratory glassware, representative lines of porcelain ware and the fused silica product known as vitreosil.

THE AMERICAN STEAM CONVEYOR CORP., Chicago, Ill., has published a booklet on the ash-handling problem, describing a steam jet ash conveyor.

THE TAYLOR INSTRUMENT COMPANIES, Rochester, N. Y., call attention to a general industrial catalog of Tycos instruments which is now ready for distribution. This new publication describes the whole line of Tycos instruments for the indicating, recording and control of temperature.

THE ELECTRIC FURNACE CO., Alliance, Ohio, has just received from the press Booklet 5B on Baily electric furnaces for melting brass. This 24-page booklet illustrates and describes a few typical installations and also attempts to answer questions that relate to fuel cost, reliability of essential furnace parts, foundry conditions, quality of metal produced and comparative metal losses.

THE VULCAN SOOT CLEANER CO., Du Bois, Pa., announces a new leaflet on Vulcan soot cleaners for return tubular boilers, which describes model "M," front end type, and model "Rb," rear end type. It shows how the cleaner is installed in settings of typical construction and gives the results of tests conducted by the engineering department of the University of Illinois, and by the Iowa Soldiers' Home at Marshalltown, Iowa.

THE MORSE CHAIN CO., Ithaca, N. Y., has issued a booklet on chain drives which is an illustrated article reprinted from the National Association of Cotton Manufacturers' 1919 Year Book.

THE MAGNETIC MANUFACTURING CO., Milwaukee, Wis., calls attention to Bull. L on its type "L" magnetic separator.

THE PORTABLE MACHINERY CO., INC., Passaic, N. J., calls attention to a folder replete with illustrations showing the various uses of the scoop conveyor, describes the labor, time and money saving features of the machine in storing, reclaiming, loading and unloading material such as coal, coke, ashes, sand, gravel, crushed stone, fertilizer, cement, chemicals, etc. Copies will gladly be sent upon request.

Stocks and Bonds

Closing Bid and Asked Quotations May 12, on N. Y. Stock Exchange

CHEMICAL COMPANIES

	Bid	Ask		Bid	Ask
Am.Ag.Ch.	109¾	110½	Mat.Al.Wk.	31	40
do.pf.	101	102	Ten. C. & C.	14¾	15
Barrett Co.	132	134½	Un. Dyewood.	50	61
do.pf.	115	120	do. pf.	..	96?
Gen.Chem.	170	178	Va.-Car. Ch.	60	66¾
do.pf.	102½	103¾	do. pf.	111	113
Int.Ag.Ch.	24½	25			
do. pf.	81¾	82			

Bonds

	Bid	Ask
Am. Ag. Ch., 1st cv. 5s, '28	99¾	99½
Am. Ag. Ch., cv. db. 5s, '24	108½	110½
Int. Ag. Ch., 1 mtg. & col. tr. 5s, '32	81½	82½
Va.-Car. Ch., 1 mtg. 5s, '23	95¾	96
Va.-Car. Ch., cv. db. 6s, '24	101¾	101¾

PETROLEUM COMPANIES

	Bid	Ask		Bid	Ask
Asso. Oil Co.	93½	94½	P-A Pet & Tr.	88½	88¾
Cal. Pet.	32½	33	do. pf.	153	156
do. pf.	78	78½	Pierce Oil.	26¾	27
Col. G. & E.	48¾	48¾	Royal Dutch.	110½	111
Mex. Pet.	177½	178	Sinclair O & R	64¾	65
do. pf.	107½	108½	Texas Co.	275	276
Ohio Cit. Gas.	47½	47¾	Tex. Pac. Ld. Tr.	300	400
do. pf.	....	....	Tidewater Oil.	245	250
Ohio Fuel S.	49½	50			
Okla. P. & R.	12½	12¾			

Bonds

	Bid	Ask
Columbia Gas & Electric, 1 5s, '27	85½	87
Col. G. & El., std. 1 5s, '27	85¾	85¾
Pan-Am. Pet. & Tr. 1 6s, '19-'27	140	
Pierce Oil, cv. db. 6s, '24	109½	110
Pierce Oil, cv. 5% Notes, '20	123	140
Sin. O. & R. 1 In.7s, '20, with stk. war.	145	152
Sin. O. & R. 1 In. 7s, '20 without stk. war.	99½	99¾
Texas Co., db. 6s, '31	102½	103
Union Oil of Cal. 1 5s, '31	93	94
United Fuel Gas 1 mtg. 6s, ser.A, '36	94¾	97

IRON AND STEEL SECURITIES

	Bid	Ask		Bid	Ask
Am. St. F.	34¾	35	Pitts.Ste. pf.	93½	100
Beth. Steel	74	76	Rep. Iron & Steel	84½	84¾
do. class B	74¾	74¾	do. pf.	103½	103¾
do. pf., 8%	110¾	112½	Sloss Sheff. I. & S.	56½	57½
do. pf., 7%	99	....	do. pf.	86	90
Central Fdry.	15	....	Superior Steel.	39	40
do. pf.	29	....	do. 1 pf.	94	96½
Col. F. & I.	44¾	45½	Trans. & W. Steel	48¾	49
do. pf.	....	122	Un. Alloy St.	46½	47
Cruc. Steel	71¾	71½	U.S.C.I.P.&F.	24½	25½
do. pf.	95	97	do. pf.	62	64
Great No. Ore	45¾	45½	U. S. Steel.	100¾	100¾
Gulf Sta. Steel	60	61	do. pf.	114½	114¾
do. 1 pf.	93	95½	Va. Coal,I&C.	63	65
Lack. Steel	74½	75			
Mid.St.& Ord.	45¾	46			
Nova Scotia Steel	62½	64			

Bonds

	Bid	Ask
Beth. Steel, 1 ext. gtd. S.F. 5s, '26	95¾	96½
Beth. Steel, 1 In. ref. 5s, Ser. A, '42	88¾	89
Beth. Steel, P. M. & I. S. F. 5s, '36	85	85½
Buff. & Susq. Iron, 1 S. F. 5s, '32	91	96
Buff. & Susq. Iron, deb. 5s, '27		
Cent. Found. 1 mtg. S. F. 6s, '21	81	84
Col. F. & I., gn. S. F. 5s, '43	91	...
Ill. Steel, db. 4½s, '40	84¾	85½
Ind. Steel, 1 mtg. gtd. 5s, '52	96	97½
Lack. Steel, 1 5s, '23	96	96½
Lack. Ste., 1 con. mtg. cv. 5s, Ser. A, '50	91½	92
Mid. St. & Ord., clt. cv. S. F. 5s, '36	88¾	89
Nat. Tube, 1 mtg. gtd. 5s, '52	97½	99
Rep. I. & S., S. F. mtg. 5s, '40	95½	98
Tenn. C. & I. R.R., gn. 5s, '51	91½	92½
U. S. Steel, S. F. 5s, '63	100½	100¾
Va. C., I. & C., 1 5s, '49	85½	85¾